Palestine Polytechnic University

College of Engineering & Technology

Department of Electrical Engineering

Graduate Project

Title

Portable Extraction Grape Juice Machine

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Dedicated

TO

Our Home Land

Our Fathers & Mothers

Our Brothers & Sisters

Our Friends

And

Every One Who Appreciate The Value of Science

Mohammad Nawaja

&

Anas Karajih

Acknowledgment

First and for most we should offer our thanks obedience
and gratitude to Allah

Our Appreciation To
Palestine Polytechnic University
College of Engineering and Technology
Department of Electrical Engineering
Our Supervisor Eng.Nizar Amr

Abstract

This project is a design a mobile machine that extracts natural grape juice from grapes plants in farms, this juice is ready to use without any preservatives. The main feature of the design is the plan to make it movable from farm to farms without need to collect the grape in one place to make it easy for farmers to extract the juice from grapes plant, so the small size and accepted the weight of machine its take in mind. The method of extraction depends on the pressured air in the balloon with specific pressure and time to extract all juice from grape without crushed the seeds, because it takes a tasty.The PLC controller automatically operate control of this machine process and it is operated anywhere because it depends on the running vehicle in the feed power source.

الملخص

هذا المشروع هوه عبارة عن تصميم الة متنقلة تعمل على استخراج عصير العنب الطبيعي من النبات العنب ، وهوه عصير جاهز للاستخدام وخالي من المواد الحافظة . السمة الاساسية للتصميم هي خطة جعلة قابل للتنقل من مزرعة الى اخرى دون الحاجة المزارعين لجمع ثمارهم ووضعها في مكان واحد ، ولذا تم اخذ صغر الحجم و الوزن بعين الاعتبار في التصميم .

تعتمد الية استخراج عصير العنب على بالون هواء مضغوط بضغط وزمن محددين بدون سحق بذور التي تعطي طعما لذيذا . تعمل وحده تحكم المختارة تلقائيا على التحكم في جميع عمليات ومراحل عمل الة وكما ان الالة تعتمد على المركبة الناقلة في مصدر التغذية من الهواء والكهرباء الازمين.

Contents

List of Figures

List of Tables

Chapter 1

Introduction

1.1 Overview

Grape juice is one of the most important natural elements ,because it contains many proteins and carbohydrates and used in the treatment of many diseases in addition to its wonderful taste at first farmers were extracting grape juice in primitive ways using hands and legs and then moved to Manual processes. In these cases, the quality of juice is not required not to mention the great effort exerted and the small amount extracted The person places the grapes manually in the basin and then is transferred by a feather to the springs that separate the grape grains from the branch and then washed in a basin and love is transmitted through a conveyor belt to the squeezing tank and then grapes are filtered.

We did a questionnaire about whether people prefer juice with or without grape seeds as see in figure 1.1 , and figure 1.2 present results are a reason for our direction of the squeezing method that got rid of the seeds.

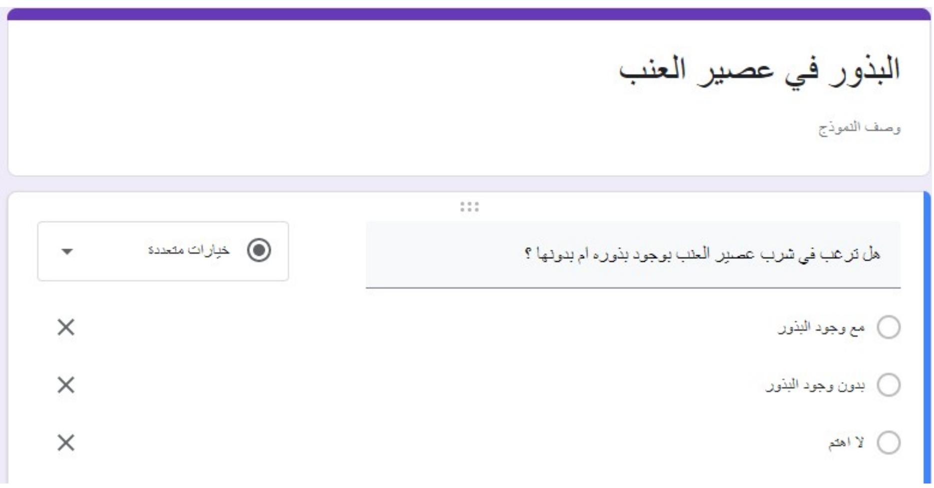

Figure 1.1: questionnaire sample about juice with or without grape seeds

In developed countries like the USA, Germany, France, Italy, Canada and Great Britain etc., the productivity of the Agricultural sector is always on the increase. These achievements result from their high level of mechanization. However, mechanization has been difficult in Palestine because of the high cost of imported machines and equipment and lack of indigenous designed, developed and built technologically advanced agricultural machines.

From the foregoing discussion, it became paramount to research, conceptualize, develop, design and produce low cost, durable and efficient machines to meet the basic needs. Such laudable developments will no doubt increase the mechanization of food production and processing in Palestine. This will consequently lead to an increase in both the quantity and quality of agricultural products available locally and for export.

Figure 1.2: results of questionnaire sample

1.2 Machine Description

In this section we described the machine process, figure 1.3 show the main task and stages.Its a sequence processes start from collection of grape ends of extractor juice.

1.3 The Present work

The present work is on the design, development and performance evaluation of grape juice extractor with emphasis on high extract yield, simplicity in operation and maintenance, cost and hygiene using locally available materials.

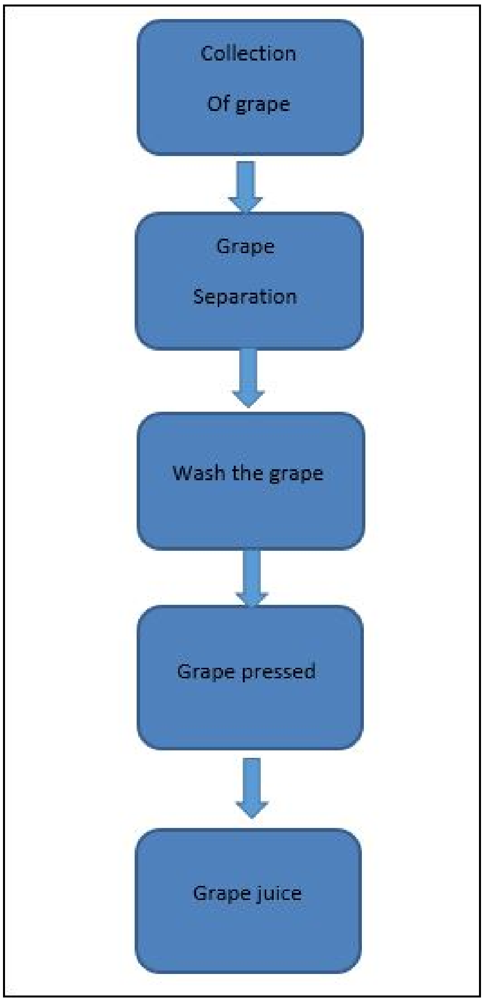

Figure 1.3: Flow Chart

1.4 Problem Statement

There are many problems that face the farmers in the course of extracting the grapes juice. In the past, fruits were processed and stages involved include squeezing the juice out with bare hands.

This method of processing is unhygieniand has low efficiency, and contributes to human drudgery. Problems associated with this are:

- Deterioration sets in almost immediately due to metabolic activities which continue even after harvest. The perishable nature makes it difficult to store and preserve the grape fruits; hence there is gradual loss of flavour and nutritional values.

- The local way of extracting grape juice is prone to contamination, and as such reduces the quality of juice produced.

- Inability of people to squeeze small amounts of grapes in factories

- Not getting the required quality of juice

- Wasting a lot of time and not getting the right amount of juice

1.5 Aim and Objectives of the Project

The aim of this work is to design, develop and carry out performance evaluation of a grape juice extraction machine. The specific objectives are to:

- Saving time and work
- Get highest amount of juice
- increase quality of juice
- Construct the extractor and assemble it(using Solid Work Software).
- To evaluate the performance of the extractor in terms of juice yield, extraction efficiency and extraction loss of fruits.
- To fabricate the machine
- design a acceptable size – scale fruit juice extractor

1.6 Significance of the study

The dietetic value of well-packaged fruit juice is far more than bottled drinks such as Pepsi, Coca-cola etc [1]. If fruits juice could be substituted for this synthetic preparation, then it will prove a boon to the consumer as well as fruit farmer.

This project is very important in that it will encourage the commercial production of fruits and therefore help to boost the agricultural sector of the economy. It will help to beat down the cost of fruit juice which can adequately serve as a substitute to bottled drinks. As a result, the consumption of fruits will increase thereby improving the health of the common man.

The juice will no longer be seen as a luxury for the high class. The cost of importation of foreign extractors which tends to reduce the country's GDP will be greatly reduced.

1.7 Justification

The successful implementation of this project work will give a boost to Palestinian Government initiative of importation ban on a of grape juice into the country. This work would enable the study of performance evaluation of the extractor and suggest ways for improvement and will propel farmers to engage in the extraction of the grape juice. To achieve this, they need such machine that is simple to design and operate.

Chapter 2

LITERATURE REVIEW

2.1 Introduction

This chapter is a review of the literature that is pertinent to the studies carried out in this work. It also specifically considers some relevant concepts such as fruit juice extraction, agricultural fruits used for juice extraction, the nutritional value of fruits and the principal methods of juice extraction from fruits.

2.2 Nutritional value of fruits

Fruits are one of the most important foods to mankind and its usefulness can be traced back to the early man ages when it serves as the foremost source of food for man during which he engaged in hunting and gathering so as to survive from age to age. These fruits contain vitamins, enzymes, minerals; natural sugars and cellulose [2]. The nutrients contained in fruit juice can be absorbed within minutes. It has low calories and so fresh fruits juice should be included in any weight lose plan to provide abundant vitamin and mineral nourishment with little calories.

It has been estimated that over 70% of cancer cases is attributed to diet. Several studies have shown that a diet high in fruits (especially Ginger fruits) protect against cancer which may be due to the high level of antioxidant these fruits contain. These antioxidants are compound found in the juice and skin of fruits which help to protect the body against free radicals and therefore may also have a role to play in preventing heart related diseases, ageing and cancer [3]. There are many different antioxidant; they include the vitamin A, C and E, the minerals manganese, selenium, zinc, copper etc.

[2] Vitamin C is required in the production of collagen, the substrate that give structure to muscles, veins, arteries, bones and cartilage. It helps to heal wounds and aids in iron absorption.

Fruit juice also contain Foliate, a B-group found imperatively consumed by women of child bearing age to help reduce the number of babies born with “spinal bifida”. Fruit juices also contain Potassium in significant quantity which help to maintain fluid balance in the body and is also important for cell structure and nerve transmission. A recent scientific study shows that most men suffering from hypertension who ate food rich in potassium were found to have 60% less chance of having stroke [2].

Drinking of fruit juice with a meal helps the body to absorb more iron from plant food especially to those segments of the population that is iron deficient. The high content of fruit sugar in grape fruits promotes secretion of bile and combats formation of gallstone and acid deposits [3].

In spite of its extensive use and its obvious benefits to man, fruits have been viewed as a sort of luxury. Historically, this may be attributed to the fact that they are available only in seasons as fresh produce. Even today, fruits juices are considered by many to be a luxury and are far more commonly included in the diet of people from developed nations like USA.
Fruit juice extraction is the process of squeezing the liquid content out of fresh fruits, to ease effective storage and prevent unnecessary wastage. The stages involve cutting, crushing, squeezing, pulping and pressing. Extraction can be done manually or mechanically depending on the volume of fruits to be processed. Fruit juice can be obtained from many types of fruit e.g. pineapple, apple, orange, ginger, cashew etc.

This transformation of locally produced fruit helps to enhance profitable farming system in various parts of Nigeria [4]. However, the processing facilities required for this transformation are inadequate and when they exist, they are usually imported with the attendant problems of maintenance and inadequate supply of raw materials in large quantities to keep the machine running efficiently [5]. Fruits processing should make the fruit safe for future consumption and maintain quality i.e flavor, odour, appearance and nutritional values.

Fruits from which the juice is to be extracted must be fully ripe since this is when their sugar content and flavor are at optimal peak [6]. As a result of this, fruits should be processed as near as to the harvest point so as to reduce transportation of fruits over long distance before processing. This will give fresher fruits and thus better quality of extracted juice.

2.3 Review of previous works

After an extensive search for information relevant to the scope of study, it was discovered that a number of globally fabricated fruit juice extractors have been developed.

[7] worked on an electrically powered juice pulping machine. It consists of an auger-sieve combination mounted on top of an aluminum frame, a handle for manual operation and produces juice free of seed and skin. The fruit press consists of a crusher mounted on top with components like screw-thread, slated cage and a crusher. The machine is a lever operated press that grinds and crushes in one operation with an output of about 25 liters of juice per hour when operated by one person.

[8] designed, fabricated and tested a fruit juice extractor for citrus. The machine has a power requirement of 1.17 kW and is operated by a 1420 rpm electric motor. The extraction capacity and extraction efficiency of the machine were determined to evaluate the performance of the machine. The machine has an average juice extraction capacity of 5.11 and 2.79 kg/hr for orange and grape respectively.

It equally has an extraction efficiency of 78.78 and 75.66% for orange and grape respectively. For orange juice extraction, the extraction capacity of the machine was found to be 280% of the manual extraction method and 304% of the value obtained using the domestic extraction cup. For grape juice extraction, the extraction capacity of the machine was 220% of the manual extraction method and 180% of the value obtained using the extraction cup.

The machine was further modified and the tapered auger was replaced with a straight auger. The modifications resulted in an increase in the juice extraction efficiency of the machine from 78.9 to 89.2% and juice extraction capacity from 5.1 to 15.8 kg/h for sweet orange. The fruits were reduced to uniform sizes and the effect of fruit size (thickness) and shaft speeds were studied with respect to machine juice extraction efficiency and capacity using regression analysis.
Fruit thickness of 20, 40, and 60 mm and shaft speeds of 300, 400, 500 and 600 rpm were used for the test. Juice extraction efficiency and capacity showed very strong quadratic relationships with speed for the 3 sizes of pineapple and orange fruits studied. The exception was apple of 60 mm thickness which exhibited a very strong linear relationship between shaft speed and machine capacity. The relationships among various parameters were established and the optimum speeds for peak performance of the machine at various fruit thicknesses were also recommended .

[9] designed and fabricated a small scale whole pineapple fruit juice extractor. The machine consists of beater blades and a shaft in conjunction with a powered screw pressing mechanism. The machine successfully processed 12 kg of ripe pineapple fruit into 8 L of pineapple juice.

[10] developed and carried out performance evaluation of a juice extractor as a function of its extraction efficiency. The extractor consisted of a screw jack, rame, connecting screw rod, pressing mechanism, interlock, feeding pot, receiving pot and discharge mechanism. Performance tests revealed a juice yield, extraction efficiency and extraction loss of 76, 83 and 3%, respectively .

[11] fabricated and evaluated a tomato seed extractor having a capacity of 180 kg of fruits/h. With a unit cost of $190, the extractor has a seed extraction efficiency of 98.8 %. Compared with manual seed extraction method, the extractor has a saving time and saving cost of 96.6 and 89.6 % respectively.

[12] designed and constructed a small scale orange juice extractor using locally available construction materials. The essential components of the machine included feeding hopper, top cover, worm shaft, juice sieve, juice collector, waste outlet, transmission belt, main frame, pulleys and bearings. In operation, the worm shaft conveys, crushes, presses and squeezes the fruit to extract the juice. The juice extracted is filtered through the juice sieve into juice collector while the residual waste is discharged through waste outlet.

Result showed that the average juice yield and juice extraction efficiency were 41.6 and 57.4 %, respectively. Powered by a 2 hp electric motor, the machine has a capacity of 14 kg/h. With a machine cost of about $100, it is affordable for small-scale citrus farmers in the rural communities.

[13] designed and fabricated an extractor for the juice and pulp of mango fruit. The machine is made up of a main frame, the hopper, anger, extraction unit, shaft, juice outlet, belt and pulley, bearing, top cover and the machine frame. The shaft of the auger has a diameter of 18 mm. The auger has a pitch of 8.8 cm. The extractor requires a power 1.42 hp, and the production cost of the extractor is less than fifty thousand Naira (N50, 000. 00). Juice extraction efficiency, juice extraction capacity and thorough-put of the machine were determined at a speed of 300, 600 and 900 rpm. The highest juice extraction efficiency of 76 % was recorded at shaft speed of 300 rpm. The highest juice extraction capacity of 26.67 L/h was recorded at shaft speed of 900 rpm. Also, highest thorough-put

value of 14.36 g/s was recorded at shaft speed of 900 rpm. The study established linear relationships between shaft speed and juice extraction efficiency, juice extraction capacity and thorough-put of the machine.

[14] designed and constructed an orange juice extractor. The machine has a diameter of 160 mm and a height of 350 mm. The juice extraction is achieved by means of small sharpened blades on a shaft which rotates with the aid of the bevel drive.
The rotation is achieved by turning the handle. The machine is designed with ease of operation and high efficiency, and combine the extraction and beating often by macerating. It consists of two main parts – a goblet and a manually operated mechanical unit. The manually operated mechanical unit consists of a pair of bevel gear casings, two bearings and two shafts.
It has a handle welded to the horizontal shaft. Small sharpened blades were made and fixed onto the impeller shaft. A bearing was then fixed underneath and a shaft passed through. A dynamic seal was put between shaft, bearing and the goblet to prevent leakage. The machine extracted about 180-220 oranges per hour into orange juice when performance test was carried out.

Chapter 3

MATERIALS AND METHODS

3.1 Introduction

This chapter describes in detail the design considerations, analysis, choice of materials, construction, operation and the experimental procedure required to test the fruit juice extractor for grape.

3.2 Description of the grape Juice Extractor Machine

Figure 3.1 shows the sectional view of the motorized juice extractor. It consists of two feeding hoppers, A grains filter strainer, conveyor , pressured balloon housed in a cylindrical barrel.cake outlet, juice outlet and main frame.

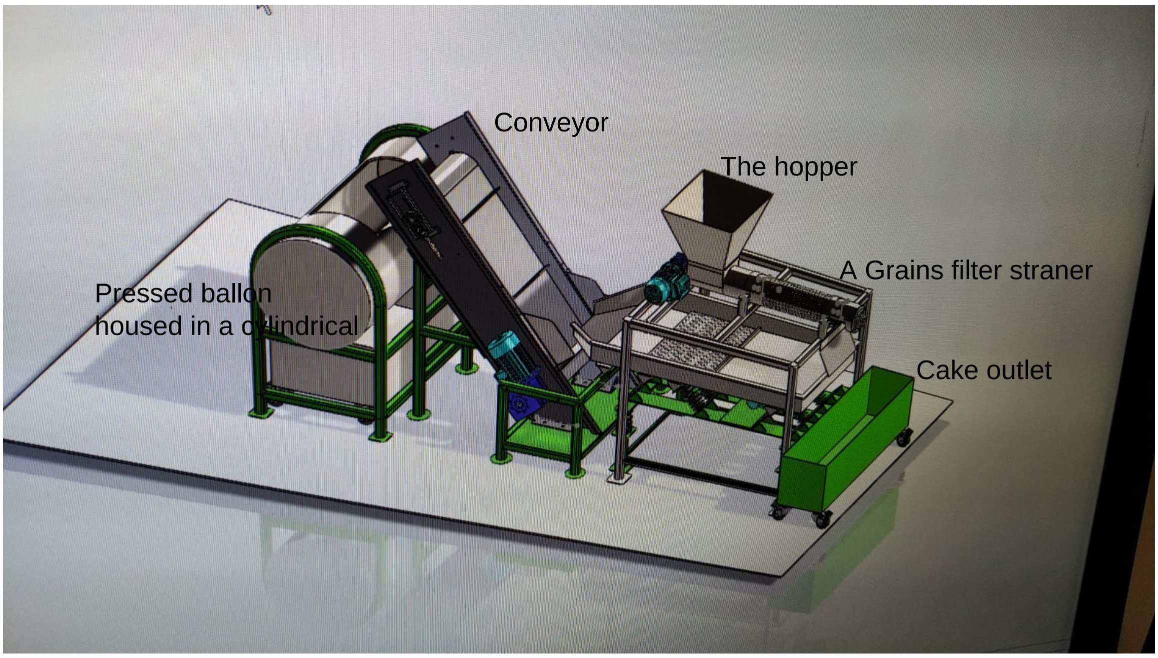

Figure 3.1: Sectional view of the grape Juice Extractor Machine

3.3 Assembly and Working Principle of the Grape Juice Extractor Machine

The grape Juice Extractor Machine was designed and Simulate in the Solid Work 2018 Software and controlled using Matlab 2010 software, and assembled as shown in Figure 3.1.

The machine is so constructed that it will remain steady on the ground while in operation.

It consists of feeding hoppers, screw (auger) conveyor housed in a cylindrical barrel, waste outlet, juice outlet and mainframe.

The grape juice extractor is designed to work on the principle of Extract, and squeezing, and is made up of six units which include:

main frame, feed hoppers, grape seed Extract unit, juice extraction unit, collecting unit and power transmission unit (Figure 3.1).

The main frame is made up of angle iron having an angle cross-section. The main frame forms a rectangular shape and supports and holds the machine components and gives it a compact design and a sturdy outlook.

The hopper is mounted on top of the grape seeds extractor compartment.The feed hoppers are trapezoidal in shape and inclined vertically in order to enable the mass flow of feed into the seeds extractor and extraction chambers of the machine. The hoppers have rectangular upper and base openings and are made of stainless steel sheet.

The screw conveyor is housed in a cylindrical barrel at a clearance of 2 mm between the screw diameter and the inside diameter of the barrel. In operation, fruits are introduced in the machine through the feeding hopper.

The machine conveys, extractor the fruit inside the cylindrical barrel with the aid of the screw conveyor until is drained through the perforations provided at the of the cylindrical barrel to vibrate on the bottom table.

The vibrating table conveys the fruit to the conveyer to feeding the extraction barrel. After feeding the extraction barrel the inside balloon is pressure to extract the juice.

The juice extracted drained through the perforation provided at the of the cylindrical barrel on the table.The residual cake is discharged at the cake outlet which houses a cone with a little clearance between the cylindrical barrel and the cone.

The flow chart (figure 3.2) simplifies the operational sequence of the designed juice extractor.

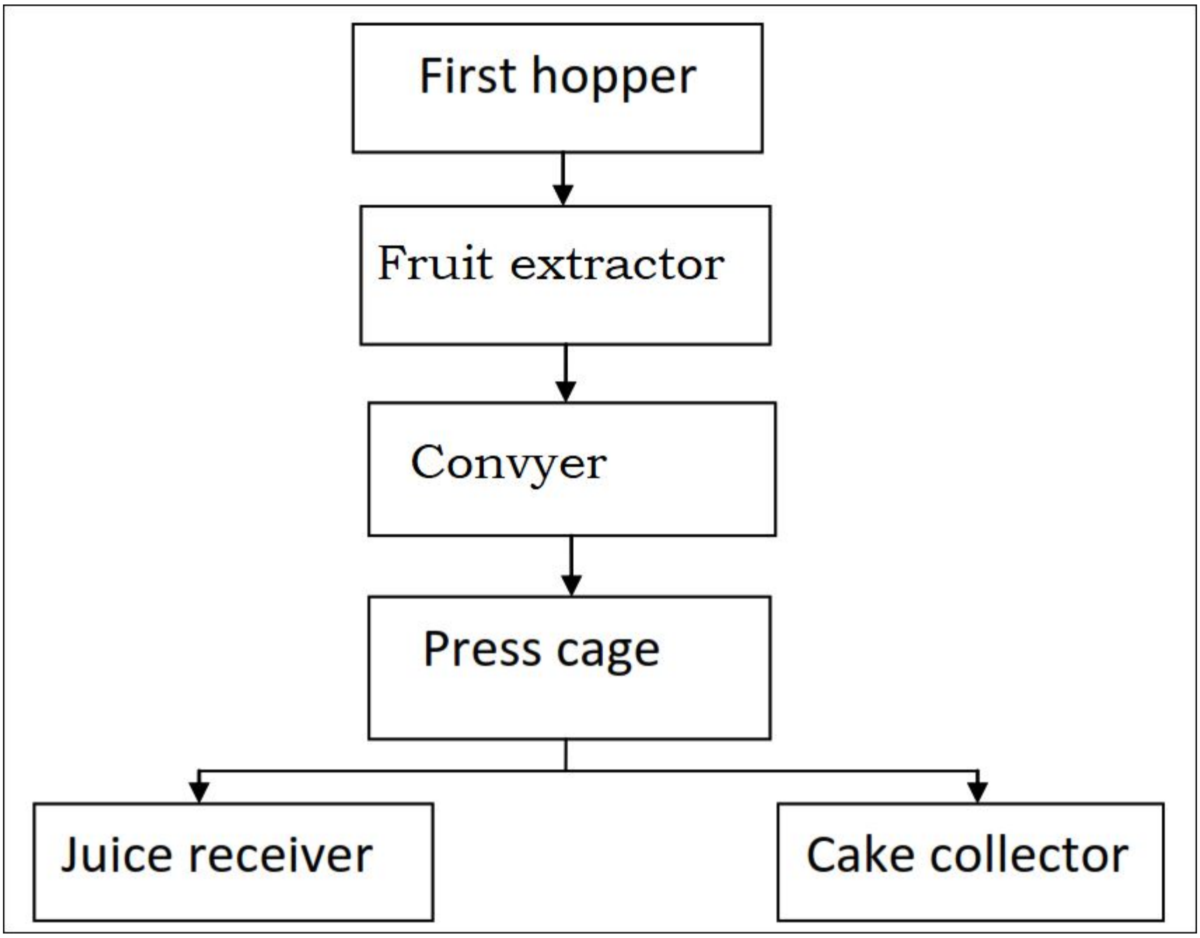

Figure 3.2: Flow chart showing the operational sequence of the designed juice extractor

3.4 Material Selection and Description

For the design of this project,Stainless steel materials will be selected considering the following qualities: Stainless steel has about 11% chromium 0.15 to 0.25% carbon content which makes it easy to be worked on and welded. It also has a density of $7.68 \times 10^3 \ kg/m^3$, heat expansive of $11.7 \times 10^{-6} \ K^{-1}$, Young's modulus of elasticity $210 \ GN/m^2$, the tensile strength of $350 \ MN/m^2$ and elongation of 30%.

The following factors are considered for a successful design and operation of the juice extractor.

3.4.1 Design Consideration

- Strength, rigidity and simplicity of materials of construction.
- The expression pressure must be high enough to ensure an acceptable level of extraction.
- The transmission belt should be properly aligned such that it permits easy rotation of the shaft auger during extraction.
- The power shaft should be rigid enough to withstand combined bending and tension stresses to which it will be subjected to while transmitting power under various operating and loading conditions.
- The required force to expel out the juice.
- Portability of the machine.
- Easy inspection, serviceability, and maintenance of the machine.
- The durability of the machine.
- moveability of the machine from farm to another.

3.4.2 Economic Factors and Safety Considerations Construction

materials will be selected based on economic factors and safety consideration. These factors are:

- Availability and the cost of construction and materials
- Durability and strength of materials
- Manufacturing /fabrication methods that will be employed in construction.
- Efficiency of extraction and minimizing juice contamination
- Corrosion resistant properties

3.5 Materials and Equipment for Performance Evaluation

The materials/equipment used in conducting the experiments are;

- Fruit Samples such as grape

- The Juice Extractor (the fabricated machine)
- Collector Pan
- Metal Plate
- Vernier calliper.
- Micrometre screw gauge.

3.6 Description of the components of the juice extractor

The feed hopper is essentially the part of the machine through which the fruit is fed into the machine. The hopper acts as a container and at the same time helps in gradually introducing the fruits into the juice extracting compartments.

The hoppers are trapezoidal in shape in order to accommodate enough fruits and gradually introduce portions of the fruits by gravity into extracting compartments.

They are constructed from 2 mm thick stainless steel plate. The first is welded to the fruit extracting compartment and the second is welded to the barrel of the machine to introduce extracting fruits into the extraction compartment of the machine.

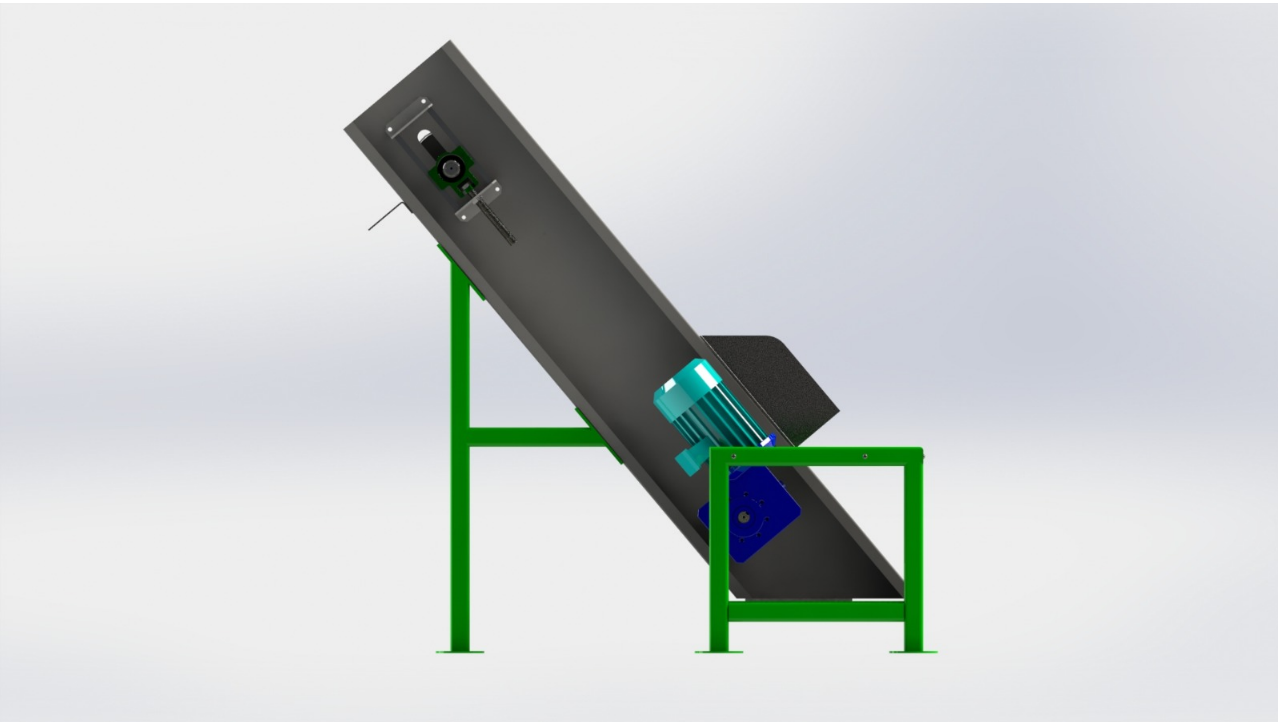

Figure 3.3: Grape Fruit Feeding Convyer to extractor barrel

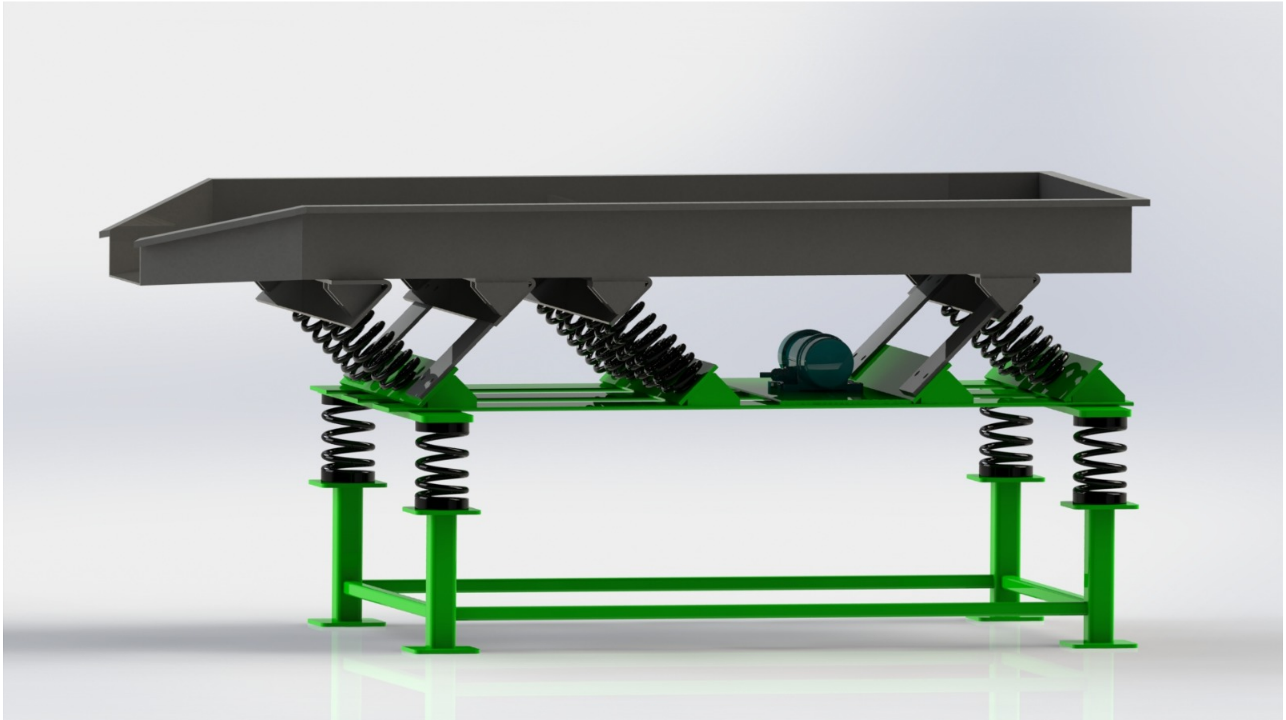

Figure 3.4: Grape Fruit vibration Table Feeding the Convyer

3.7 The Fruit extracting compartment

The Fruit extracting compartment of the machine comprises the shaft with slides housed in a drum-like steel casing into which extracting of the fruits takes place as shown in Figure 3.3. In operation, fruits from the first hopper are gradually introduced into the Fruit extracting unit; they are extracting by the Slots in the barrel wall of the drum and then moved by the machine into the extracting compartment via the conveyor.

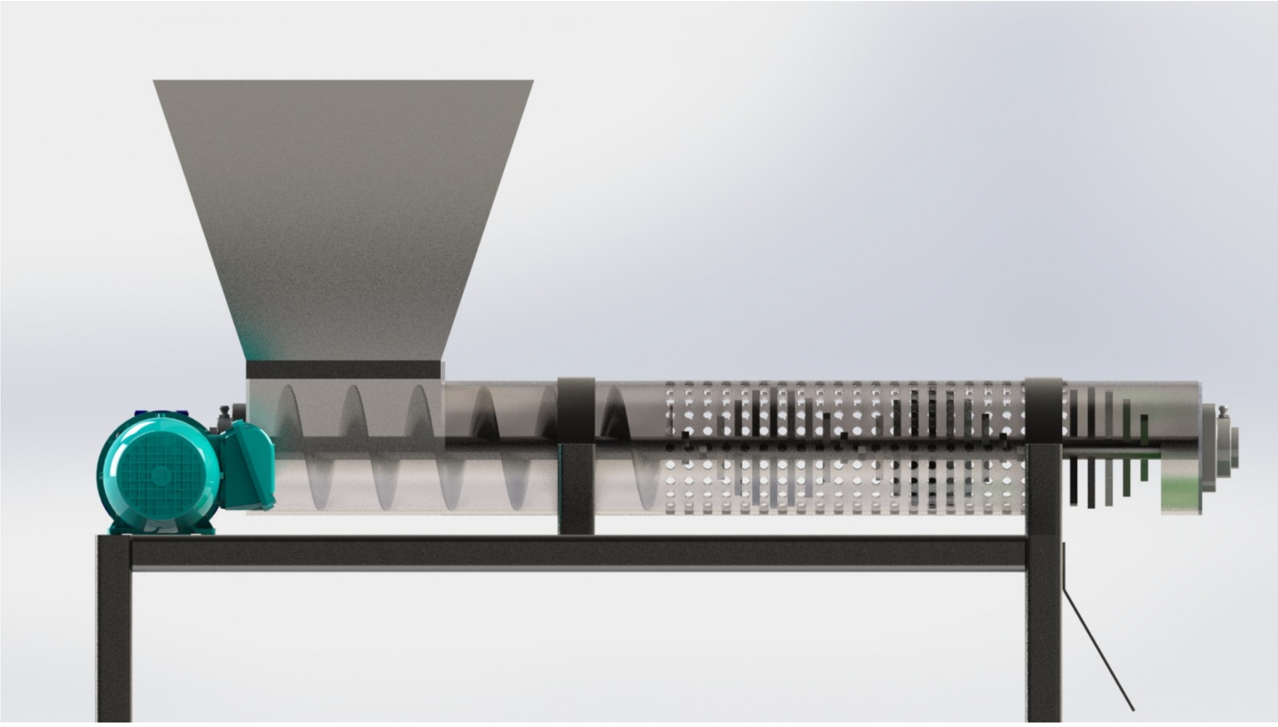

Figure 3.5: Fruit extracting compartment

3.8 Juice Extracting compartment

The extracting compartment of the machine comprises the cylindrical barrel which houses a pressured balloon is supported by the side of the barrel at both ends as shown in Figure 3.6.

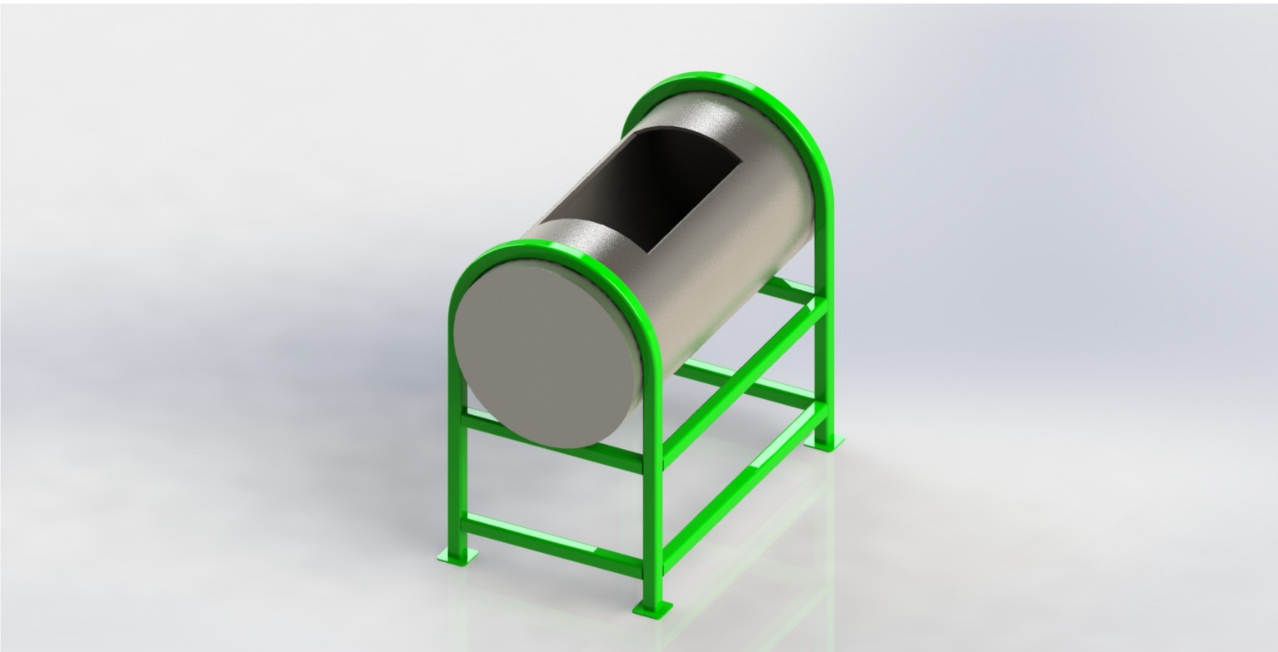

Figure 3.6: Juice Extracting compartment

3.9 The frame and stand

The frame and the stand, fabricated from angle iron bar are the parts of the machine that provide supports for both the juice extractor and the electric motor as shown in Figure 3.1. The frame also provides rigidity when the machine is in operation.

3.10 The outlet compartment

The outlet compartment comprises two major outlets: the juice outlet and the cake outlet. The juice outlets are perforations drilled below the cylindrical barrel unto which a sieve made of stainless steel for juice collection attached. The cake outlet is joined to the posterior end of the barrel and the two outlets are designed to discharge the extracted fruit juice and the fruit residue (or fruit cake) simultaneously.

3.11 Construction Processes

The design specification gives particular and quantitative information about the machine to be constructed and takes certain factors such as ease of fabrication into consideration. With respect to this work, fabrication involved the use of available tools, machines and technology to transform the design drawing in paper work to rigid components and assembly of the fruit juice extraction machine. The materials were selected based on the following requirements:

- Rigidity
- Corrosion resistance
- Cost effectiveness
- . Ease of fabrication and availability of equipment e.g. welding machine, hack saw, file etc.
- Non reactivity to the juice to be extracted.

The requirements of relevant parts relating to function, stress condition and service life was considered by selecting suitable materials as described below:

- **The hopper**: was constructed from 1 mm thick plate of stainless steel because of non-reactivity to juice.

- **The barrel**: was constructed from stainless steel of 4 mm thick for rigidity ,resistance to corrosion and non-reactivity to juice compared with mild steel.
- **The frame**: was made from angle iron of 2 mm thick to provide rigidity, strength and ease of fabrication.

Chapter 4

Electrical Design

4.1 Introduction

The development of machines is an important step in all fields of industry,because of its important effect in increasing production, reducing its errors,increasing quality, reducing effort,reducing time, reducing costs.
In this chapter we will design and select and calculate we will size compressor; also, Protection circuits will be the size. Power circuit and control circuit will be explained.

4.2 Required Component

4.2.1 Pneumatic Components

The principles of pneumatic are the same as those for hydraulics, but pneumatic transmits power using a gas instead of a liquid. Compressed air is usually used, but nitrogen or other inert gases can be used for special applications.With pneumatic, air is usually pumped into a receiver using a compressor.The receiver holds a large volume of compressed air to be used by the pneumatic system as need.Atmospheric air contains airborne dirt,water vapour,and other contaminants, so filters and air dryers are often used in pneumatic system to keep compressed air clean and dry, which improve reliability and service life of the components and system.Pneumatic systems also use a variety of valves for controlling direction, pressure, and speed of actuators.

Pneumatic holds many advantages that make it more suitable for many applications.Because pneumatic pressures are lower, components can be made of thinner and lighter weight materials, such as aluminum and engineered plastics,wheres hydraulic components are generally made of steel and ductile or cast iron.Hydraulic systems are often considered rigid, whereas pneumatic systems usually offer some cushioning, or "give." Pneumatic systems are generally simpler because air can be exhausted to the atmosphere, whereas hydraulic fluid usually is routed back to a fluid reservoir.

Air Compressor

An air compressor is a device that converts power (using an electric motor, diesel or gasoline engine, etc.) into potential energy stored in pressurized air (i.e., compressed air). By one of several methods, an air compressor forces more and more air into a storage tank, increasing the pressure. When the tank's pressure reaches its engineered upper limit, the air compressor shuts off. The compressed air, then, is held in the tank until called into use. The energy contained in the compressed air can be used for a variety of applications, utilizing the kinetic energy of the air as it is released and the tank depressurizes. When tank pressure reaches its lower limit, the air compressor turns on again and re-pressurizes the tank.

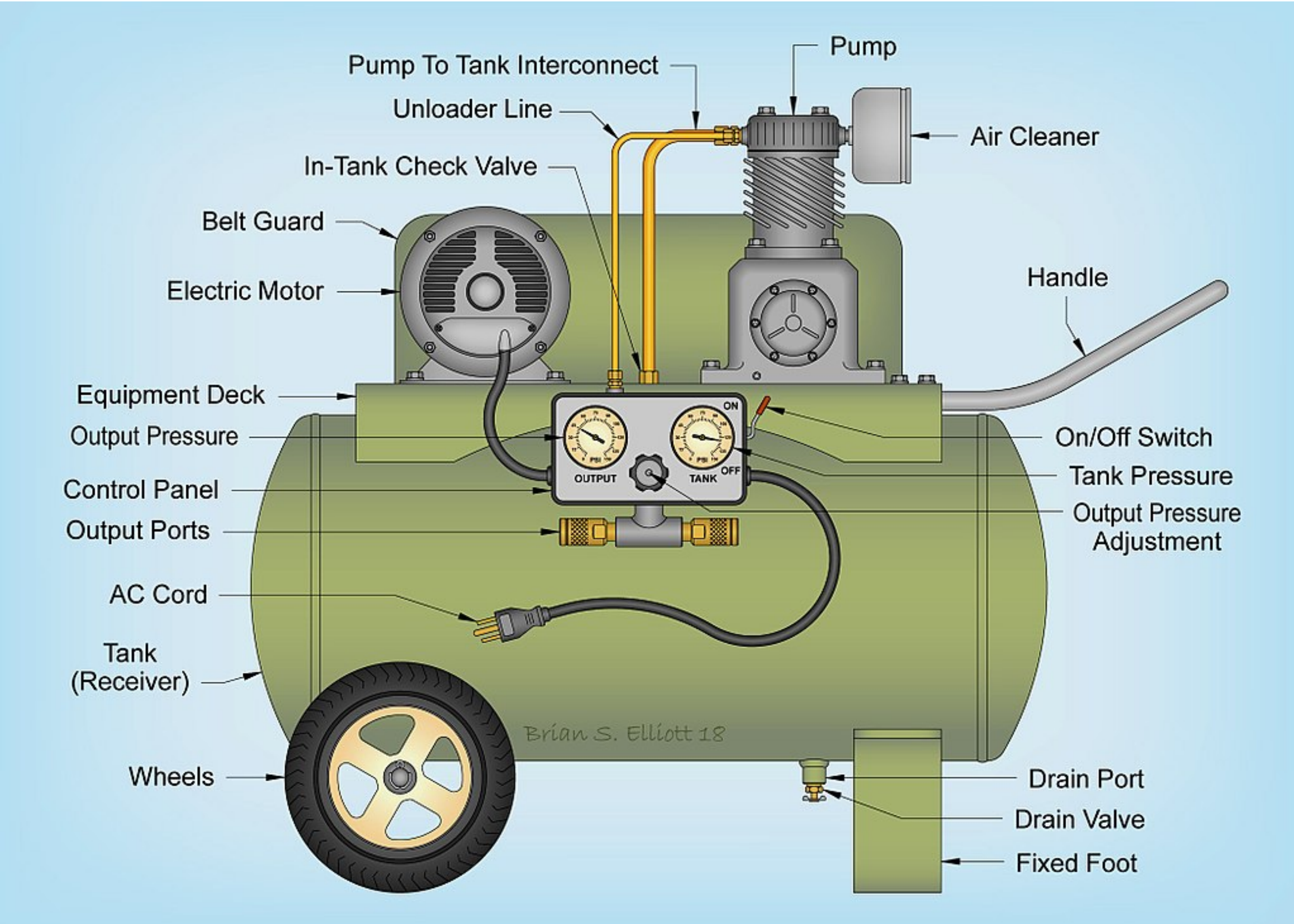

Figure 4.1: Technical Illustration of a portable single-stage air compressor

Conductors

Tubing, hoses, fittings, manifolds and other components that distribute pressurized air throughout the system.

Figure 4.2: Air pipe

Valves

Devices that control fluid flow, pressure, starting, stopping and direction.

Figure 4.3: 5/2-way solenoid valves

Pressure Sensors

This sensor helps to control the amount of air entering the balloon

Figure 4.4: Pressure Sensors

4.2.2 Protection & Switching Devices

Every motor needs an overload, three-phase circuit breaker that is used to protect the motors and their installations also, an earth leakage circuit breaker. In addition, they need 5V contactor to control the motor ON/OFF operations. Emergency switch is also needed for emergency cases.

Figure 4.5: Circuit Breaker

Figure 4.6: 5-V Contactor

Figure 4.7: Overload

Figure 4.8: Earth Leakage

Figure 4.9: Emergency

4.3 Protection Circuit Sizing

The following table describes selected loads specifications(Table 4.1).

Table 4.1: Electrical Load and Protection Calculation

Device	Phase	Power / w	Voltage	Amper	speed (rpm)	frequency /Hz	I Over Load	I MCB
Motor1	1∅	183	220	0.63	30	50	0.66	1.58
Motor2	1∅	59	220	0.27	30	50	0.284	0.675

$$I_{OL} = I_n \times 1.05 \tag{4.1}$$

$$I_{MCB} = I_n \times 2.5 \tag{4.2}$$

4.4 Motor Calculation and Sizing

.

4.4.1 Fruit extractor Motor

- v = A * H

  =π*r^2*H

  =π*0.07*0.8=0.176m^3

V:volume
A :area
H:high
D:density
m:mass
p:power

M=V*D =0.176*1000=176kg
P=m*g*(d/t)
=176*9.81*(0.8/10)
=138 Watt

(4.3)

(4.4)

4.4.2 Feeding Conveyor Motor

v= w*H*D

= 0.4*0.03*1

=0.012

M=v*d=0.012*1000 = 12kg

P=m*g*(d/t)=12*9.8*(1/2) = 59 watt

Chapter 5

INTEGRATION OF MODELING IN SOLID WORKS AND MATLAB/SIMULINK ENVIRONMENTS

5.1 Introduction

Current technological development has caused an increase in customers requirements for designed products. Different conditions and competition on the market mean that new products must be characterized by high quality and functionality. This situation forces engineers to design machines which are characterized by great flexibility and a variety of applications.

However, the construction of prototypes of all kinds of devices, which are subjected to experimental research, is impossible because of both economy and time. Therefore, the modelling problem is useful and it plays a fundamental role in the design stage of a new structure as well as during the modification of existing construction.

The development of software used to computer-aided design causes that the geometrical models of objects not only can be built, but also one can perform kinematic, dynamic, and strength analysis on the basis of these models in the professional CAD system. However, it is complicated or even impossible to add control in these applications.

Therefore, very often modelling of control systems is performed in Matlab environment with Simulink module. Other alternatives, but rarely used method of visualization and control of movements of the working machines maybe the Python programming language with appropriate libraries. However, in this case, the preparation of simulation models is much more laborious and requires programming skills in Python. Matlab is intended to solve complex mathematical problems and generate a graphical visualization of the results. Its scope includes various fields of science and technology. Matlab also provides numerous extensions (toolboxes), among them, support for neural networks or optimization problems. One of the extensions is the Sim-Mechanics Toolbox which facilitates the creation of kinematic chains, simulation of their dynamics and visualization of results.

Simulink is a tool that allows deafening the structure of the control system of mechanisms of the created models and displaying their simulation with complete control during a specified working cycle. This module makes it possible to create, in the graphical window, the structure of the control system which is built of various types of blocks representing dynamic objects, signal sources and measuring instruments. By defined objects, the software can refer to variables existing in memory and available in Matlab

5.2 Construction of simulation model

The simulation model is built in stages, that is, at first solid, surface, or hybrid model is created in one of the CAD programs. Solid Works, Pro/Engineer and Auto-desk Inventor applications work preferably with the Matlab/Simulink environment.

An assembly of elements can be used solely for simulation studies because in such cases there exists an interaction between individual parts, which in turn makes it possible to introduce the control system and perform motion analysis. Therefore, each created simulation model is an assembly of many individual parts or sub-assemblies.the Grape Juice extractor Machine CAD model presented in Figure 5.1 consists of #n assemblies and #m parts, but these assemblies include subsequent assemblies or parts, etc.

The building of each part of the geometric model in SolidWorks, similar to the ones most currently used for this kind of applications, begins with defining a 2D geometry that creates a solid or a surface after completing one of the numerous operations (e.g. extrusion or pocket). Then, based on the expansion or modification of the obtained element made by removing or adding material, the creation of parts is continued. The majority of CAD systems offer normalized elements that can be used to build assemblies. The product that is the result of the final assembly of components has a permanent link to the individual part files, which means that changes made in one of the files are automatically ascribed to the linked files, respectively. The product doesn't have its own geometry, instead, it consists of a set of links to the parts and constraints that are used to connect these elements.

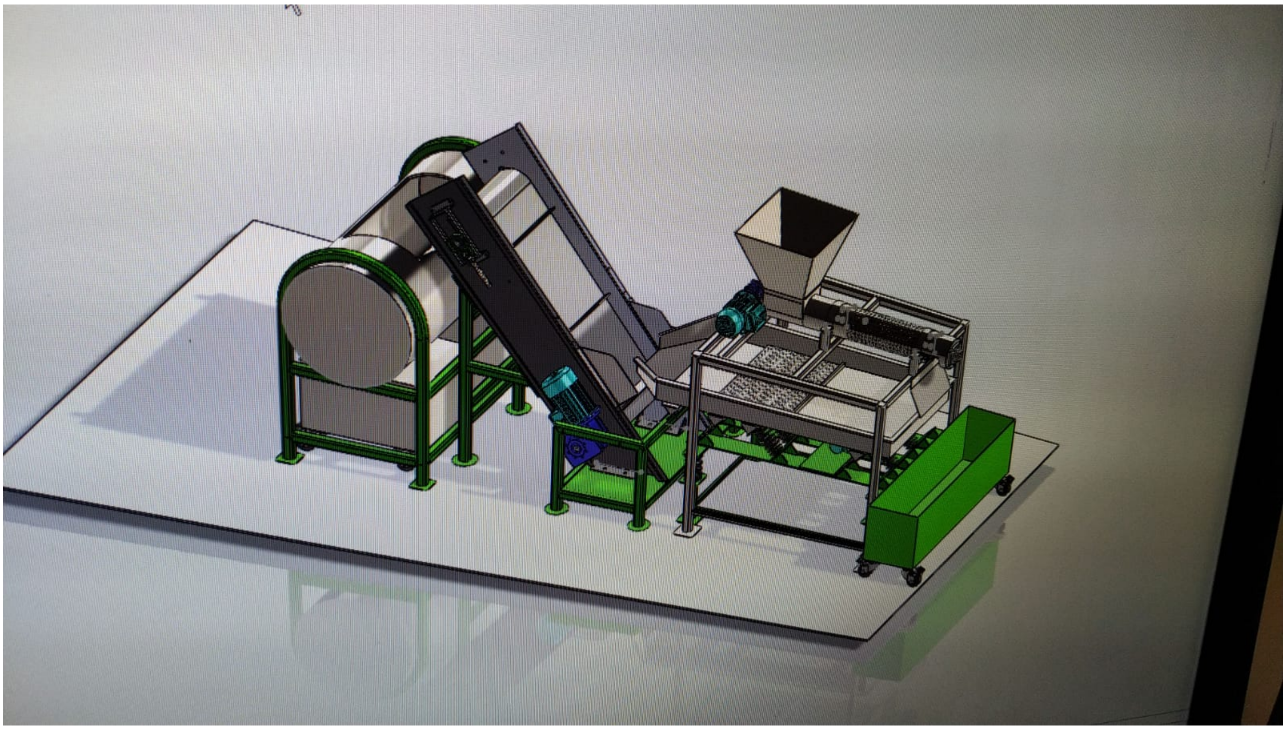

Figure 5.1: Solid Work Machine Model

The constructed geometric models should be parametric, which allows changing dimensions of components and their positions relative to each other in order to do the analysis of motion according to the same model.

Geometrical models can be used not only for the construction of the simulation model but in a very simple way they can be utilized to carry out other types of analysis, such as modal or stress analysis. In this case, the calculation model which takes into account contact connections and boundary conditions should be worked out.

The next stage of building the simulation model is the implementation of the CAD assembly model in Matlab/Simulink environment (Fig.5.2).

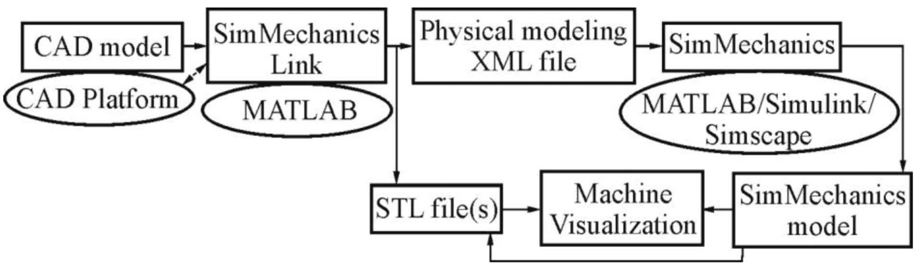

Figure 5.2: Implementation process of CAD model in Matlab/Simulink environment

For this purpose, besides previously mentioned CAD software and Matlab/Simulink, the Sim-mechanics Link utility has to be installed and linked to the CAD program.

The first step of the implementation process is to use the Sim-mechanics Link exporter to create Physical Modeling XML file that includes information about the mass and inertia of each part of the assembly, definitions of constraints between parts, as well as a set of STL (stereo-lithographic) files for representing surface geometries of the assembly bodies.

The second step is the import of the received files into the Matlab/Simulink program and generation of a Sim-Mechanics model. The Sim-Mechanics model obtained immediately after the implementation, includes a block scheme (Fig. 5.6) and allows only visualizing mechanism or machine (Fig. 5.7), without the possibility of carrying out simulation research. Only rarely it is optimal and does require modification like removing unnecessary constraints between elements of the model or changing their types.

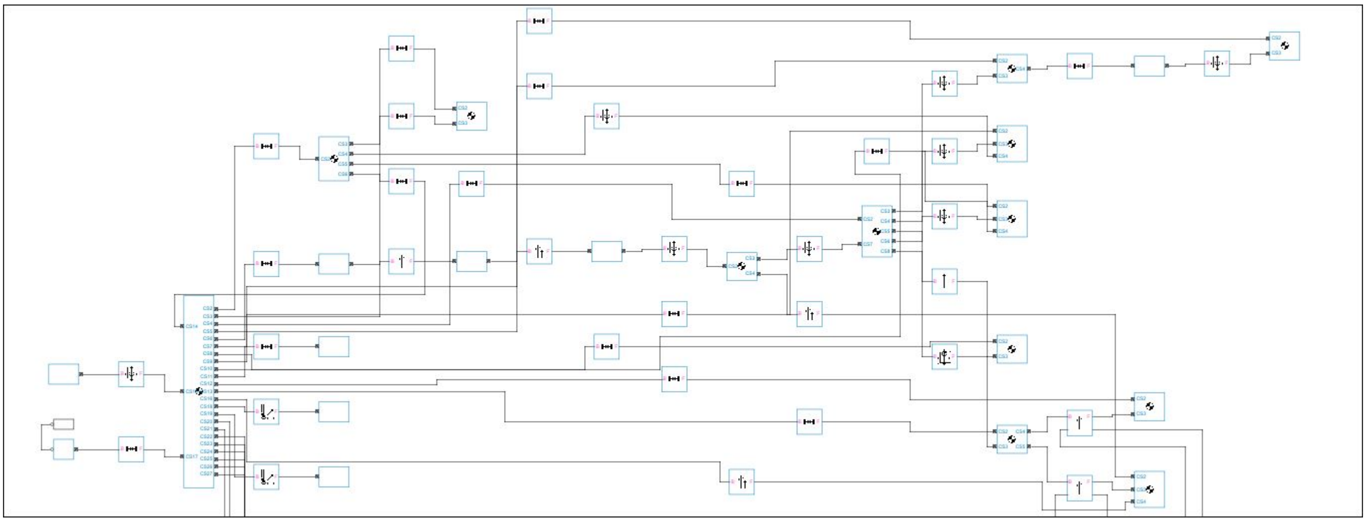

Figure 5.3: A Sim-mechanics block diagram of Feeding Convyer

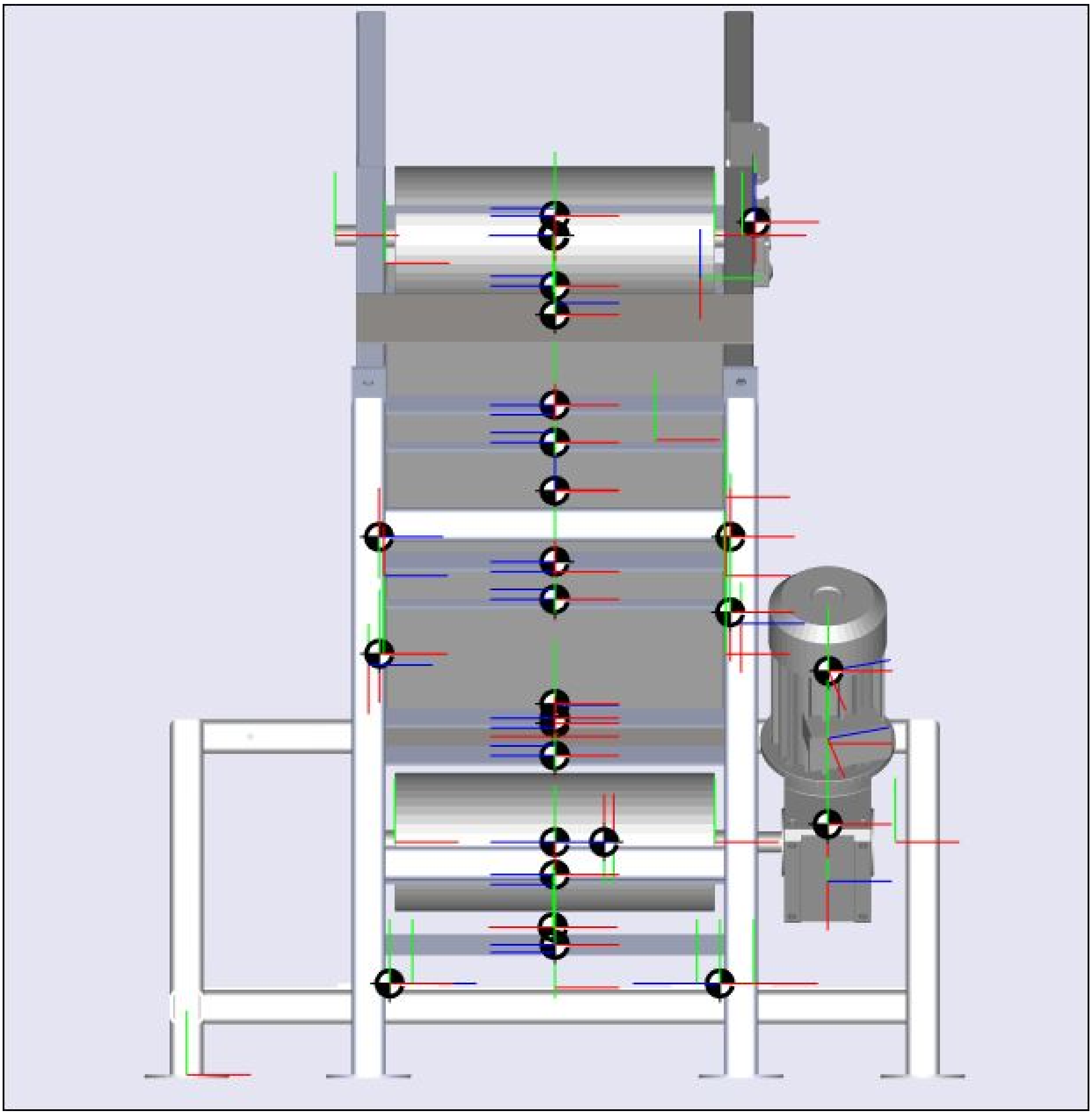

Figure 5.4: Visualization of a Feeding Convyer SimMechanics model

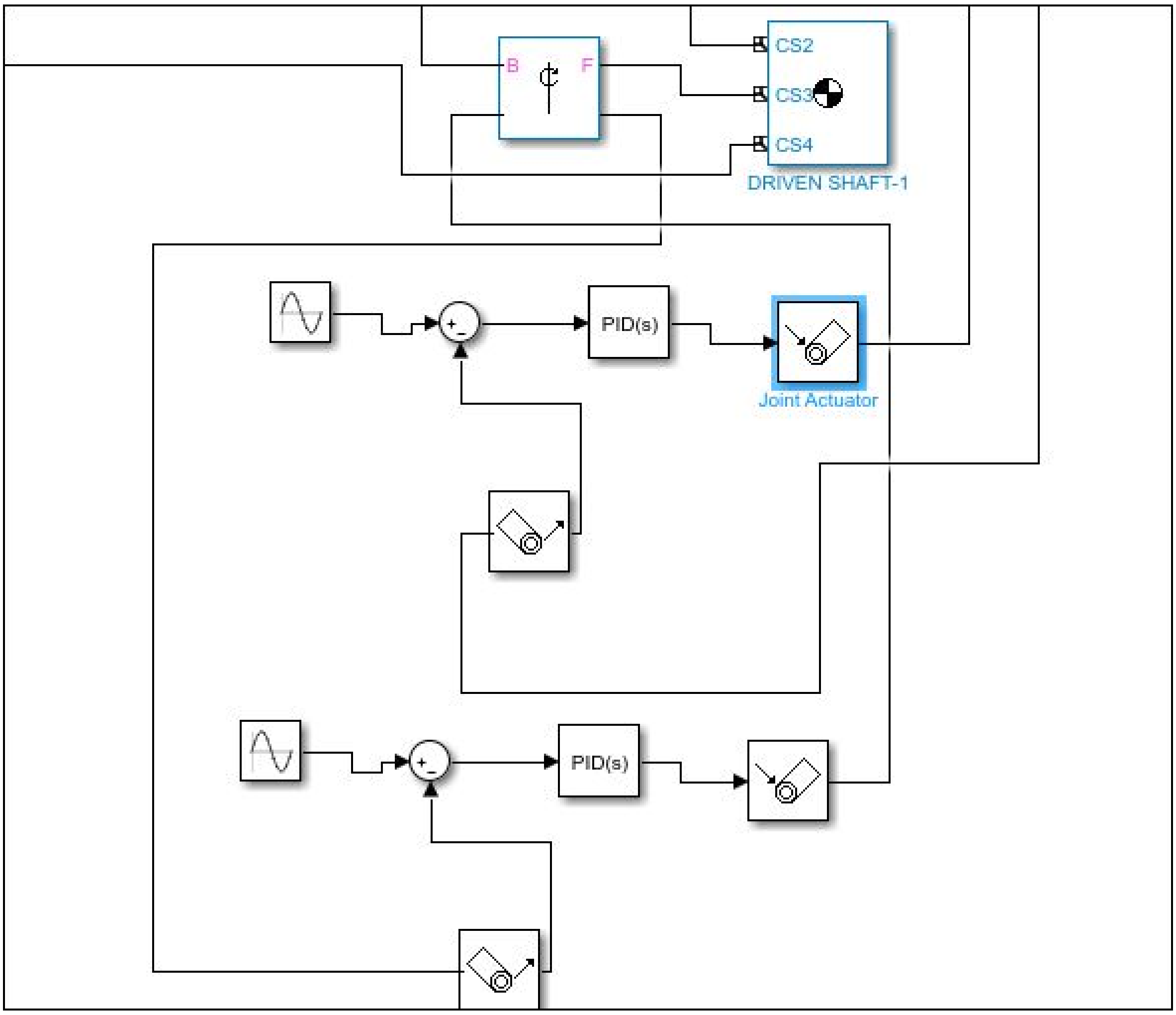

Figure 5.5: PID Controller of the control signal of a Feeding Convyer Sim-Mechanics model

Sim-Mechanics models allow determining variety of parameters, such as trajectory, velocity, and acceleration of any element of complex system by adding measuring instruments. Sometimes MATLAB/Simulink environment does not offer elements which appear in many simulation models. In such cases, it is possible to draw up own scripts and functions that can simulate such components.

5.3 The simulation model of Extraction Grape Juice Machine

The next Figure of a simulation model worked out according to the explanations presented in section 2 illustrates the simulation model of an extraction grape juice machine.

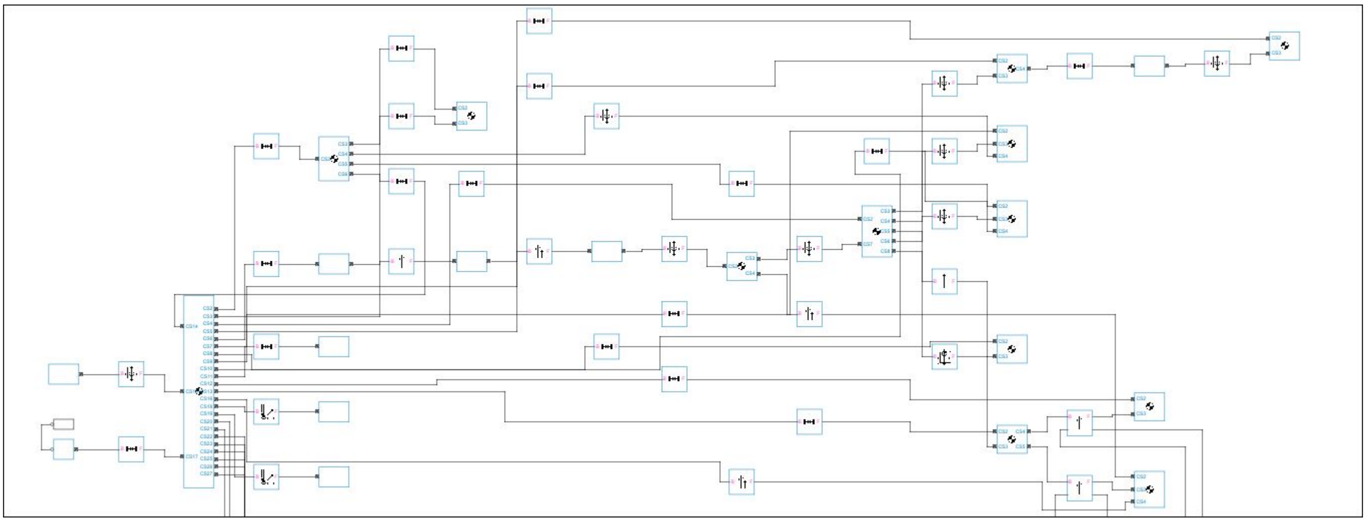

Figure 5.6: A Sim-mechanics block diagram of Feeding Convyer

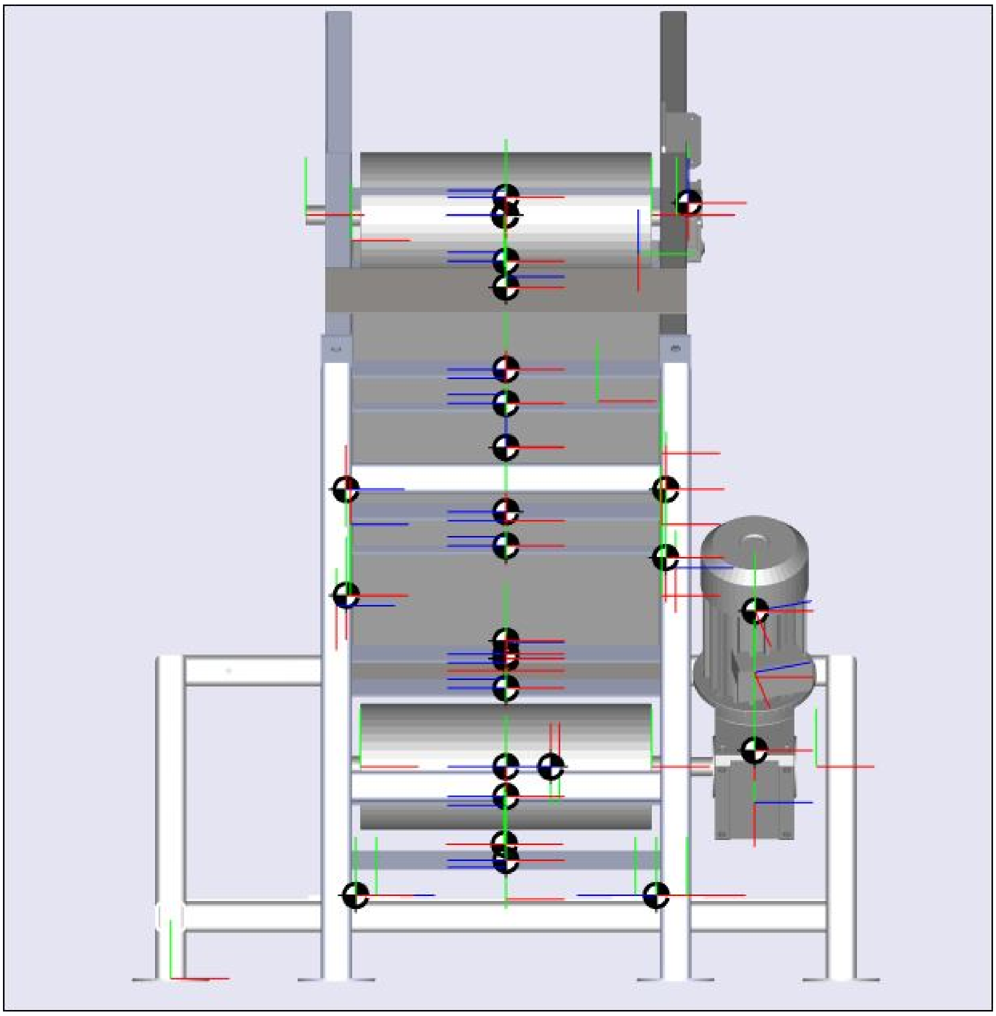

Figure 5.7: Visualization of a Feeding Convyer SimMechanics model

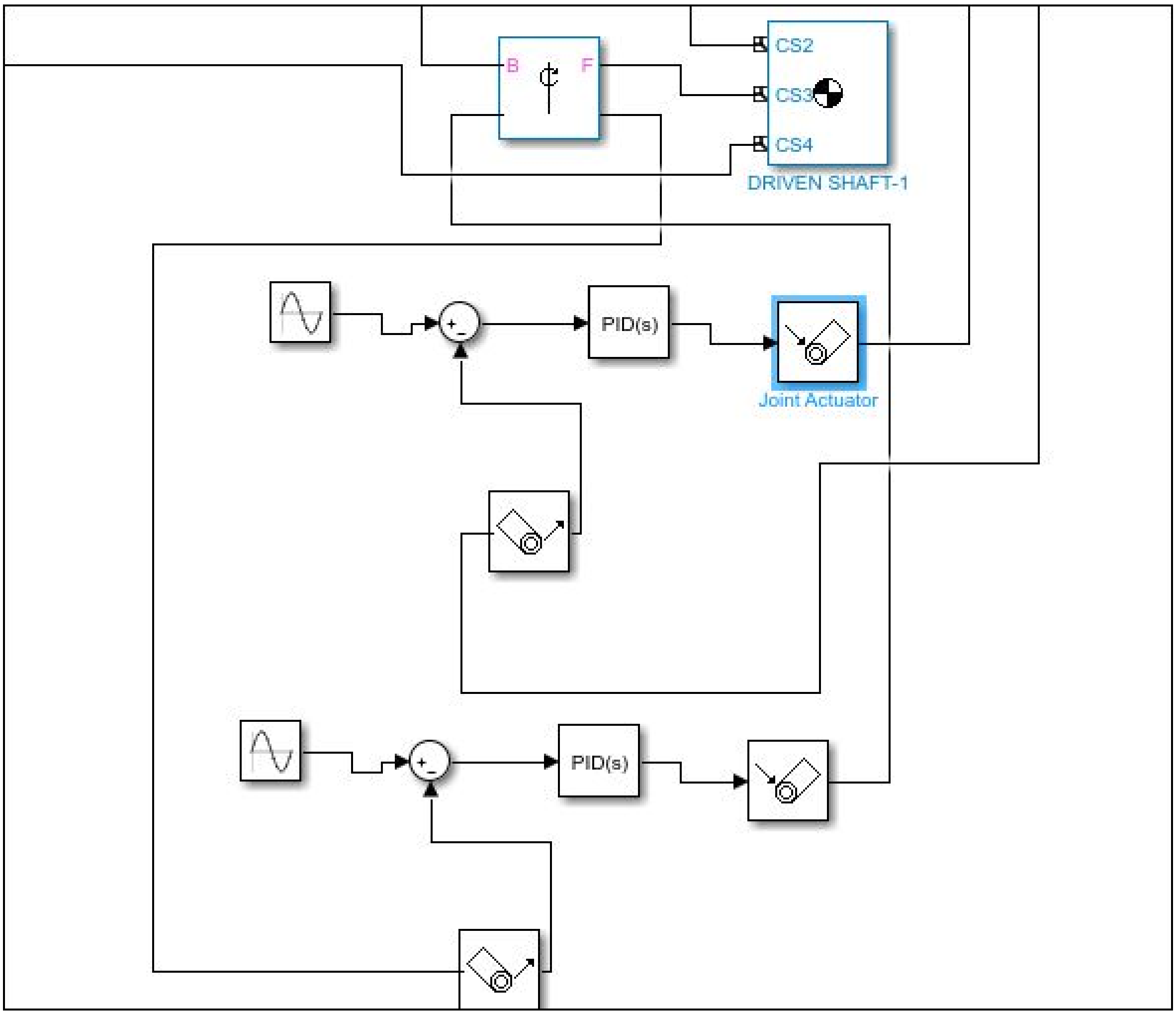

Figure 5.8: PID Controller of the control signal of a Feeding Convyer Sim-Mechanics model

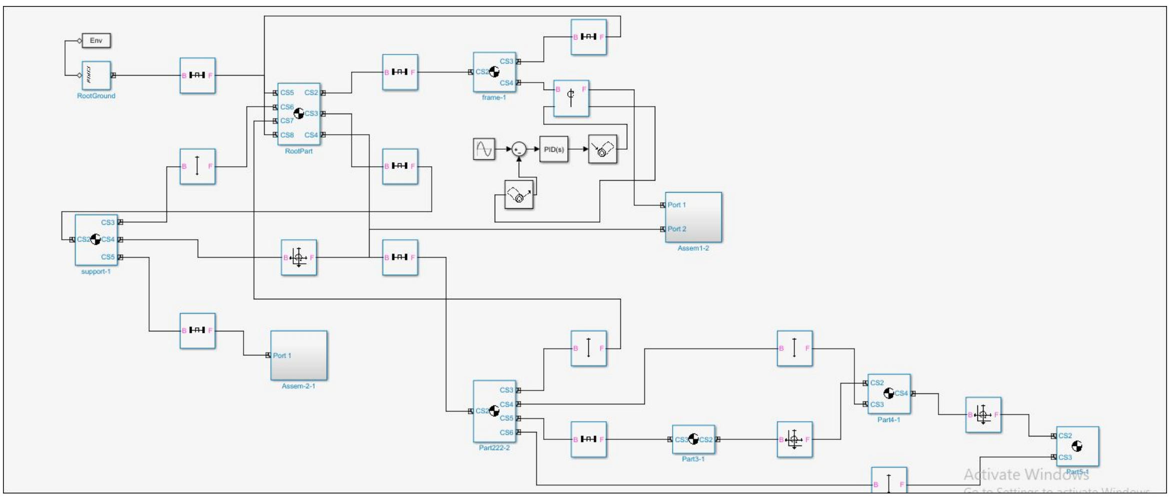

Figure 5.9: A Sim-mechanics block diagram of Vibration Table

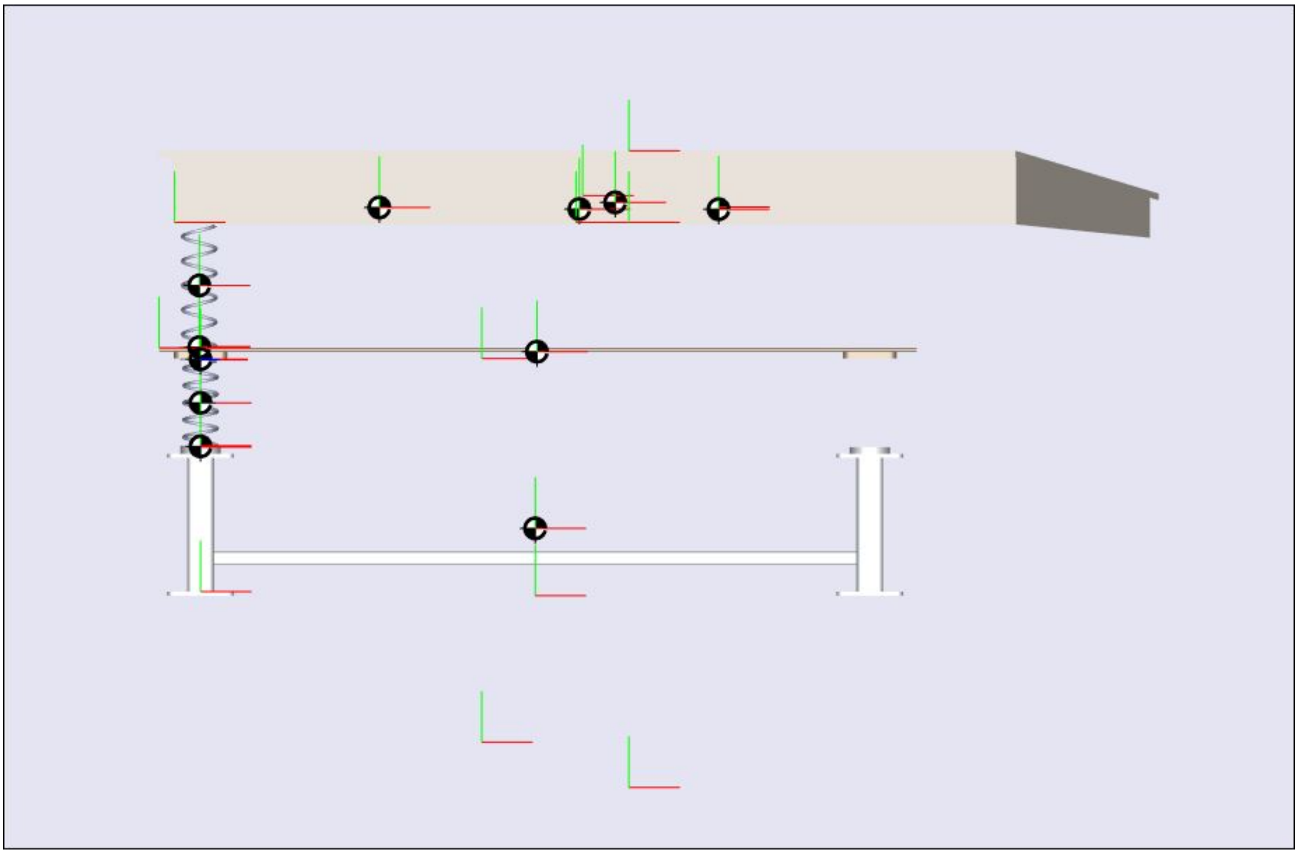

Figure 5.10: Visualization of a Vibration Table Sim-Mechanics model

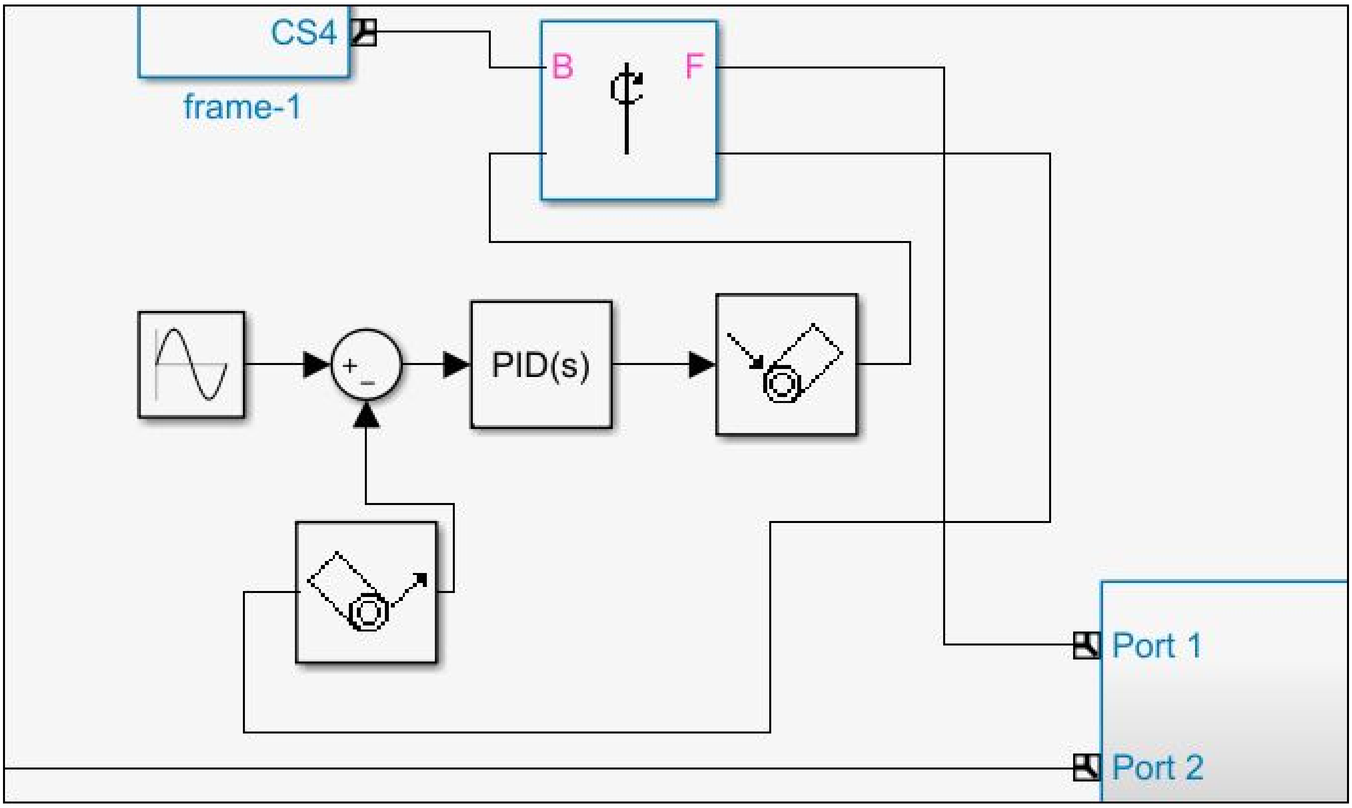

Figure 5.11: PID Controller of the control signal of a Vibration Table Sim-Mechanics model

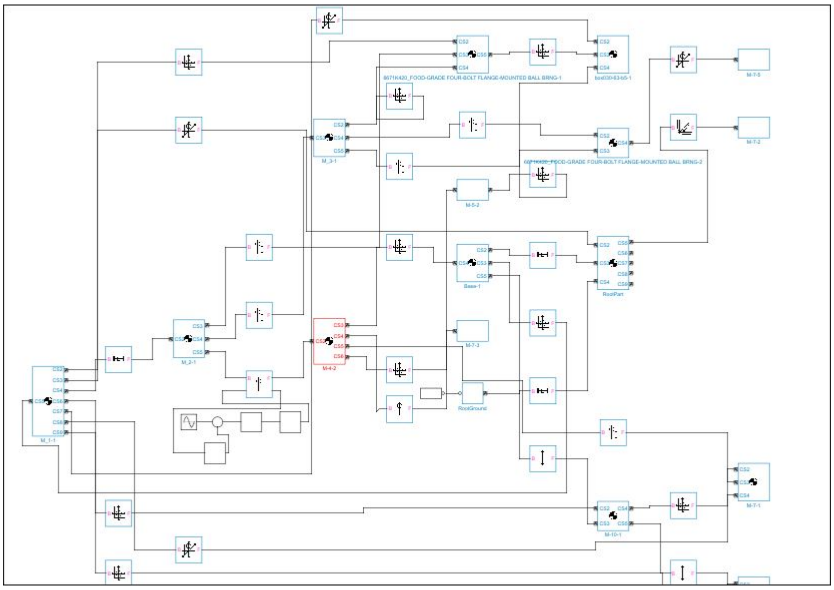

Figure 5.12: A Sim-mechanics block diagram of Fruit extractor unit

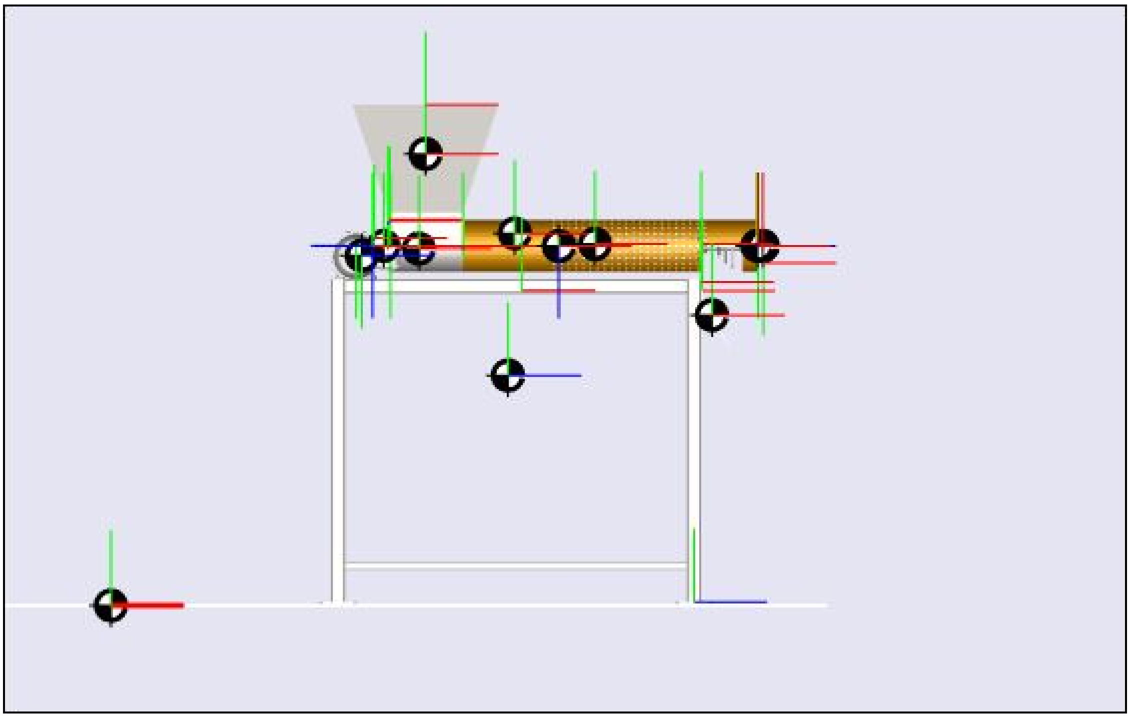

Figure 5.13: Visualization of a Fruit extractor unit Sim-Mechanics model

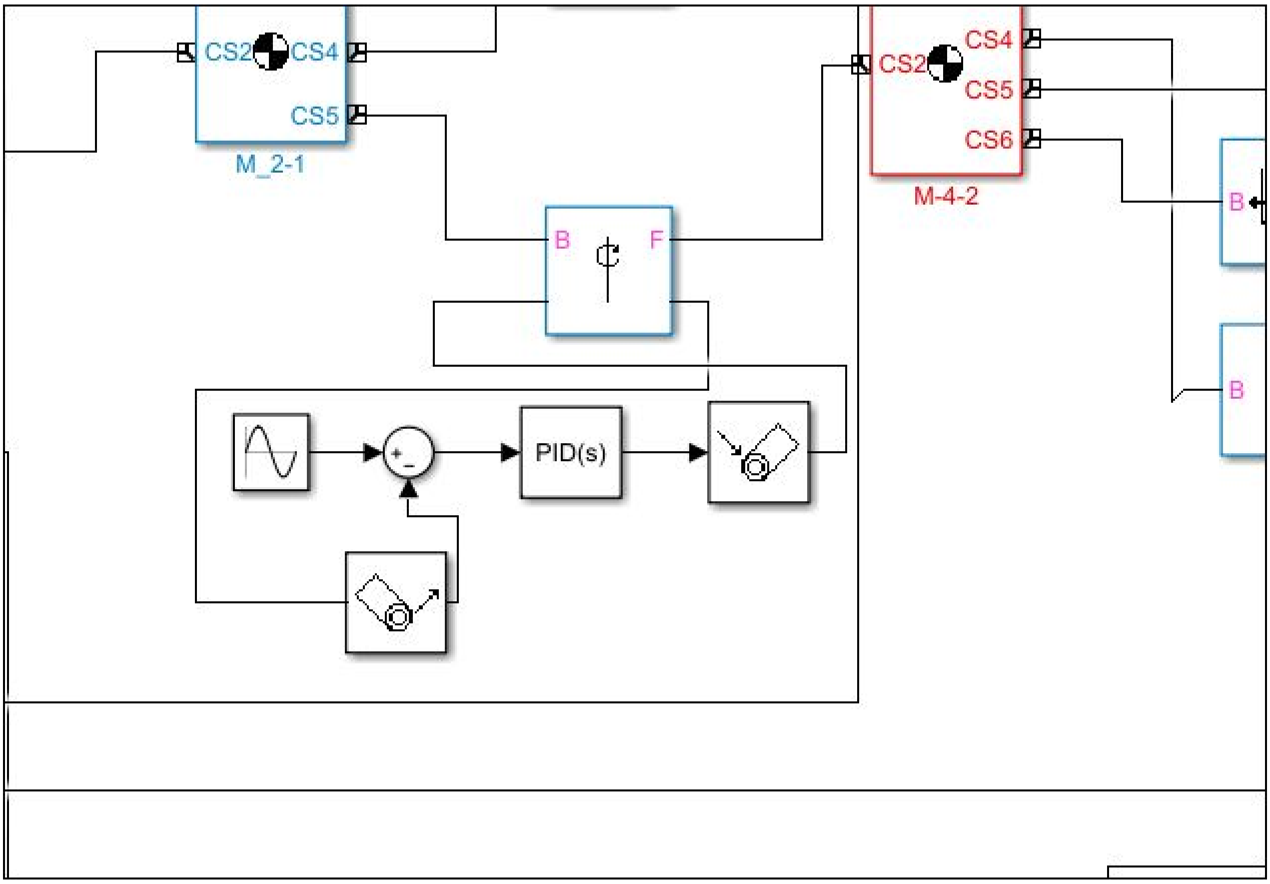

Figure 5.14: PID Controller of the control signal of a Fruit extractor unit Sim-Mechanics model

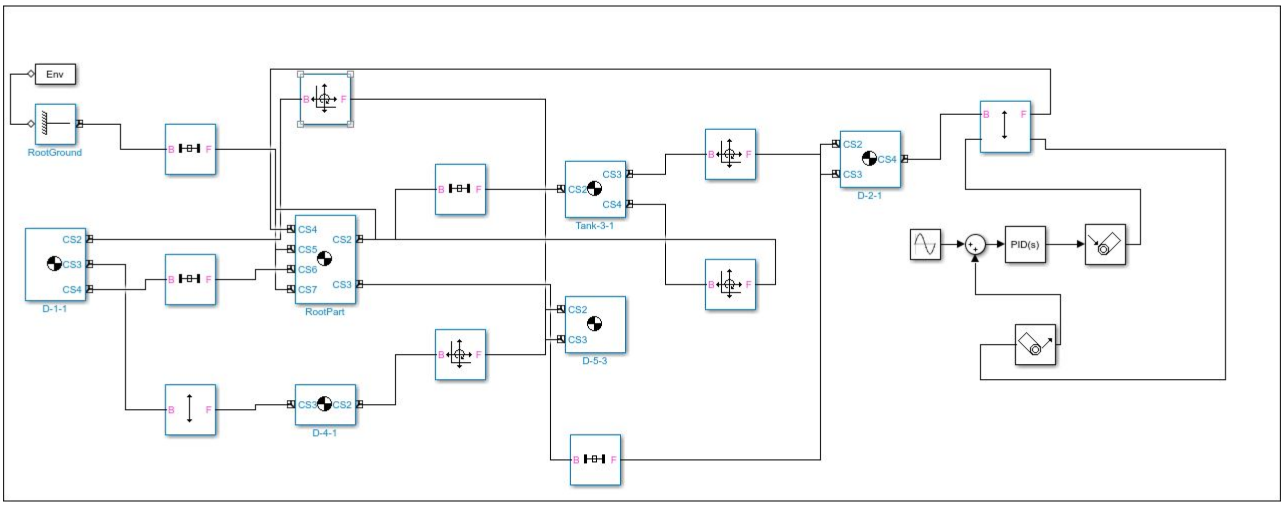

Figure 5.15: A Sim-mechanics block diagram of Juice Extraction Unit

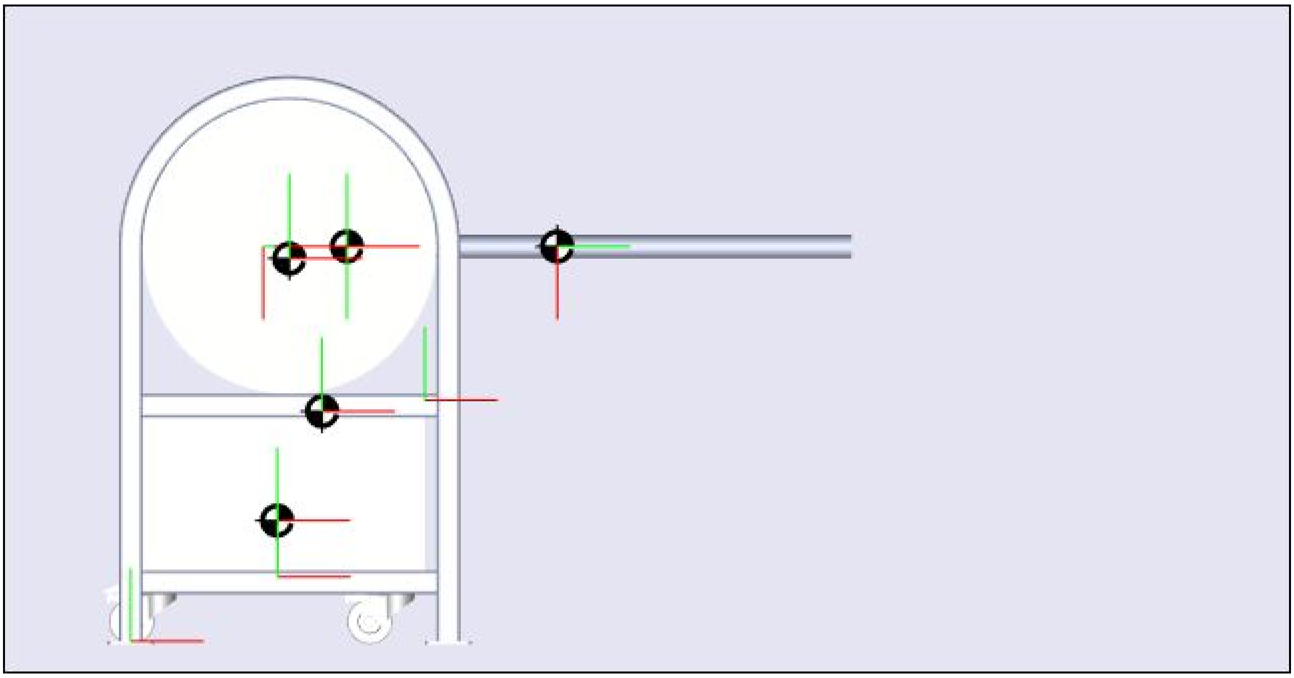

Figure 5.16: Visualization of a Juice Extraction Unit Sim-Mechanics model

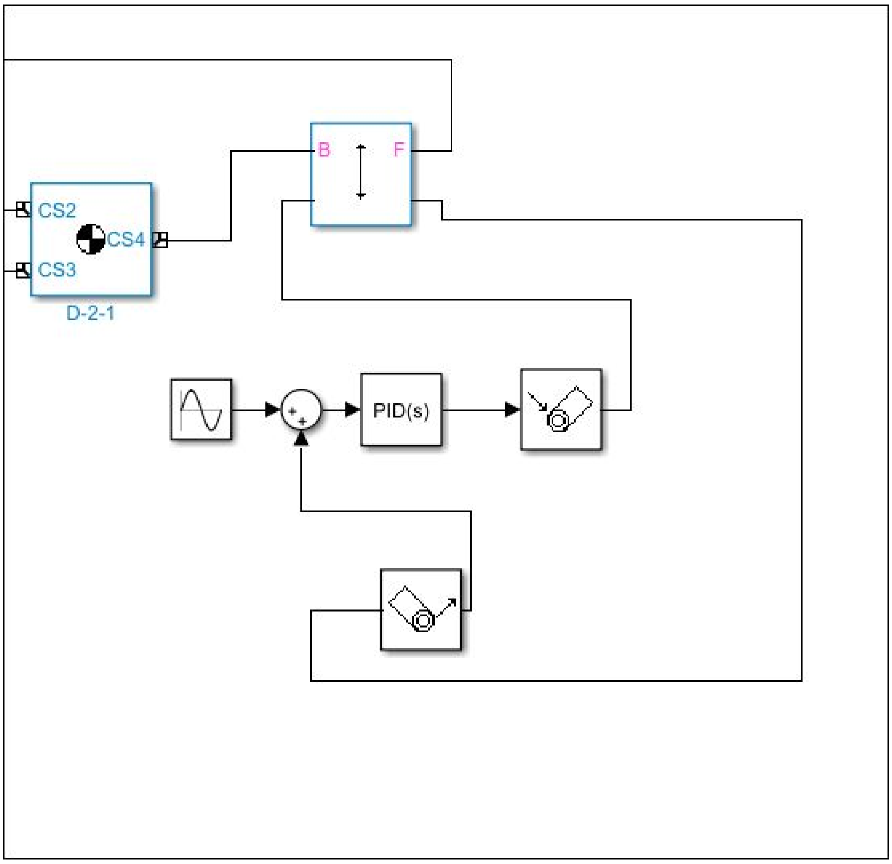

Figure 5.17: PID Controller of the control signal of a Juice Extraction Unit Sim-Mechanics model

Chapter 6

Conclusion and Recommendations

6.1 Conclusion

The design analysis of the fruit juice extraction machine was carried out and the machine successfully constructed, assembled and tested using engineering software, selected all material and component of the machine with taking into account the food use in all manufacturing materials (stainless steel)and all calculation and controlled scheme of motors and compressor is done. design all process and stage using Solid Works software and test and control using MATLAB software. all process of extraction is controlled except washing stage its remain manually.

6.2 Recommendations

- Building the machine and work it, because is a powerful tool for farmers and increase the quality and quantity of grape juice.
- Automated the process of washing grains and making them automatically so as to adjust the amount of wastewater and spent.
- The perforation of the inner cylinder should be increased in order to allow free flow of the extracted juice.
- The pulping machine should be incorporated to separate the juice from the fruit pulp thereby avoiding blockage of the perforations.

6.3 Contributions to the knowledge

The following are some of the contributions to the knowledge of this work: 1. The work has recast the drudgery of manual juice extraction method and the expensive importation of fruit juice extracting machines to Palestine. 2. The work has established that the efficiency of extraction of a juice extractor depends on the speed of extraction S, (rpm), feed rate F (kg/min) and nature of the grapefruit.

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