KLE TECHNOLOGICAL UNIVERSITY

HUBBALLI, KARNATAKA

SENIOR DESIGN PROJECT ON

"CAPSICUM GRADING AND SORTING "

Under the Guidance of

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CERTIFICATE

Certified that the Senior design project work entitled

CAPSICUM GRADING AND SORTING

Is a bonafied work carried out by

Jigar N Hundia, Punit Mahajan, Ganesh Reddy, Aniket Jain in partial fulfillment for the award of degree of Bachelor Engineering in **AUTOMATION AND ROBOTICS** of the KLE Technological University, Hubballi during the year 2021-22. It is certified that all corrections/suggestion indicated for internal assignment have been incorporated in the report deposited in the departmental library. The project report has been approved as it satisfies the academic requirements in respect of project work prescribed for the Bachelor of Engineering Degree.

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ABSTRACT

The vegetables(capsicum) are inspected for quality by human inspectors. Manual inspection of large quantities of fruits is a tiresome or monotonous and labor-intensive task. Human inspectors view the fruits and assign quality scores depending on fruit quality for suitable grading them with some scores. Although human vision is best at analyzing very complex scenes, it loses its precision for carrying out a repeated task like the inspection of fruits. To overcome such drawbacks this project proposes an automated inspection system for the vegetable grading and sorting industry based on image processing techniques.

This system can detect the stale capsicum and basically focuses on grading according to color any damages in capsicum. The sorting is done to differentiate a good capsicum with stale capsicum. The capsicum is compared with the data set trained in CNN mobile net algorithm using the image processing. Sorting of capsicum is also done. The system uses robotic operating system for sorting and grading. The successful implementation of the Algorithm gives an accuracy of 80% of detection of vegetable. Thisoutstanding achievement of results reflects that this automated system can effectively replace manual detection of vegetables grading and sorting with more accuracy and efficiency.

ACKNOWLEDGEMENT

We would like to take this opportunity to thank the following for the unique opportunity created through the course on Senior Design Project to work on the given need statements.

Any endeavor in the field of software development is purely teamwork. A successful project is a fruitful culmination of effort by many people, some directly involved, some others who quietly encourage and extend support from the background. The sense of contentment that accompanies the successful completion of our task would be incomplete without mentioning the people who helped in accomplishment of this project, whose constant guidance,support and encouragement resulted in its realization.

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We express profound gratitude to our Registrar **Dr. N H Ayachit** for his support and for providing us with the best education facilities in our campus.

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CHAPTER 1

INTRODUCTION

AI innovation has become one of the quickest and quickly developing fields all through the recent a long time because of extraordinary benefits of high precision rate, high dependability and ease of use. Numerous businesses utilize this innovation to push ahead by beating numerous impediments confronted. This venture depends on machine vision, which is one of the numerous applications that PC innovation has demonstrated to offer. The vegetables(capsicum) are investigated for quality by human overseers. Manual investigation of enormous amounts of organic products is a dreary and work escalated task. Human overseers view the leafy foods quality scores relying upon organic product quality for reasonable evaluating [1]. A machine vision framework makes a model of this present reality climate from pictures. Machine vision has served in numerous businesses to further develop their proficiency in different applications. In the advanced world, pretty much every industry is being computerized to accomplish relative benefits over manual activity The nature of human judgment is relying upon earlier information, preparing, encounters of the assessing representative. Other principal drawback is that the choice Nature of vegetable (fortunate or unfortunate) may differ contingent upon the individual to individual. Further, assessments for a significant stretch might cause eye weakness and the cerebrum will get worn out which might prompt wrong examination. Subsequently in a manual investigation framework we can expect just a low exactness rate. To conquer such downsides this task proposes a mechanized investigation framework for the vegetable evaluating and arranging industry dependent on picture handling strategies. This framework can distinguish the flat capsicum and fundamentally centers around reviewing as per shading any harms in capsicum. The arranging is done to separate a decent capsicum with old capsicum.

The principle point of this task is to plan a mechanized assessment framework for vegetable reviewing and arranging industry settling down sides of the current manual examination frameworks. Improved Exactness and effectiveness for evaluating and arranging great with old capsicum is the fundamental goal of the venture

1.1 PROBLEM STATEMENT

Among the post-reap activities to deal with products of the soil, reviewing assumes an indispensable part to eliminate bothersome or unfamiliar issues from the gathered yields into different portions. Evaluating is arranging or ordering foods grown from the ground into various grades as indicated by the size, shape, shading, and volume to bringing high market costs. The tasks, in particular, Cleaning and Arranging, impact the reviewing system radically. Along these lines, deliberate reviewing is an essential for the effective advertising of leafy foods. Further, they ought to be evaluated by their size, weight, shape, shading, development and so on the evaluating system is completely motorized, however in India, it is as yet done physically. The vital post-gather activities that should be done for leafy foods are cleaning, reviewing, and arranging. This guarantees that the leafy foods are protected, new, have a more drawn-out timeframe of realistic usability, and further develop deals.

1.2 NEED STATEMENT

To build an application of machine vision-based System, aimed to replace manual based technique for grading and sorting of capsicum using the concepts of robotics, automation and concepts of machine learning, deep learning, etc.

1.3 PROBLEM DESCRIPTION

1.3.1 MOTIVATION

The organic products are assessed for quality by human monitors. Manual assessment of enormous amounts of natural products is a dreary and work escalated task. Human assessors view the leafy foods quality scores relying upon natural product quality for reasonable evaluating. Albeit human vision is best at analysing0 exceptionally complex scenes, it loses its accuracy for doing a rehashed task like the assessment of organic products. Picture handling offers answer for the robotized organic product size evaluating to give exact, dependable, reliable and quantitative data separated from taking care of huge volumes, which may not be accomplished by utilizing the human graders [1].

1.3.2 GOALS AND OBJECTIVES

In development towards feasible farming framework, obviously significant commitments can be made by utilizing arising and advance advances. Picture handling has been ended up being successful device for investigation in different areas and applications. Different uses of picture handling in horticulture field, for example, imaging procedures, weed location, illness recognition and natural product arranging and reviewing [2].

CHAPTER 2

LITERATURE SURVEY

2.1 EXISTING SIMILAR PROJECTS

The chosen need statement has some existing solutions but they are not completely independent or intelligent for detecting the Stale or good capsicum and are also not quite affordable in the Indian market.

AI and image-based technologies plays an important role in improving product quality, food product safety, and freeing up human resources for meaningful work [3]

The innovation to identify the degrees of value and arranging has been created to assist with acquiring greatest outcomes and with a brief timeframe. This innovation has been created by evolved nations to be applied in arranging machines and quality control of agrarian items. In any case, in India this innovation has not been broadly utilized for the reasons for arranging and evaluating agricultural items in light of the fact that the gear is still somewhat costly. Different advances that can be applied to programmed arranging and unraveling machines are computerized picture handling (Picture Handling). Great picture handling can be gotten when joined with a dynamic framework that can furnish results with high exactness. This innovation is less expensive in light of the fact that it just requires a charge couple gadget (CCD) camera and a PC outfitted with outline grabber pictures, which are asof now broadly accessible on the lookout [4].

The PC vision-based framework for programmed evaluating and arranging of horticultural items like Capsicum and Tomatoes dependent on development level. The utilization of machine vision-based framework, planned to substitute manual based procedure for reviewing and arranging of leafy foods. The manual takes care of gotten issues with keeping up with consistency in evaluating and consistency in arranging. To accelerate the cycle just as keep up with the consistency, consistency and exactness, a model PC vision based programmed reviewing and arranging framework is created [5].

As a general rule, the degree files are shape, size, shading, development, abandonment, and so forth with the advancement in PC picture vision innovation, the degree procedure

dependent on PC vision has created. The PC vision degree innovation is constant, evenhanded, non-horrendous, and can identify multi-file all the while, like size, abandonment, shading, shape and the development. There are many reports about subjective assessment of farming items like - to decide the impact of mechanical collect, tomato assortments were mechanical gathered and assessed in lab.

2.2 EXISTING COMMERICALLY AVAILABLE PRODUCTS

- Natural Storage solution Pvt. Ltd Project
- It provides us with advanced sorting & grading fruits and vegetables.
- The company manufactures machineries for grading according to weight, size, color, internal quality etc.
- They also have accessories of washing treatments, brushing treatments, waxing system and etc.
- Tomra Food industry, it Manufacture most ideal and cost-effective optical food sorting machine for the IQF vegetables and fruit processing industry [6].
  QTechnology (Industrial Machine Vision Food Grading): By incorporating different vision frameworks for modern review, they have acquired broad information on the different difficulties related with mechanical joining, cleaning, and material taking care of in machines, and the limits this frequently forces on vision frameworks. as far as speed, lighting and picture enlistment in the business. conditions [3].

Figure 2.1 Existing Commercial product by Q Technology

- Vegetable Grading Using Tactile Sensing and Machine Learning
- Automatic Fruit Grading Machine by FRESH Vegetable Machine
- Automatic Fruit Vegetable Grading Machine
- Automated Sorting and Grading of Vegetables Using Image Processing for Strawberry

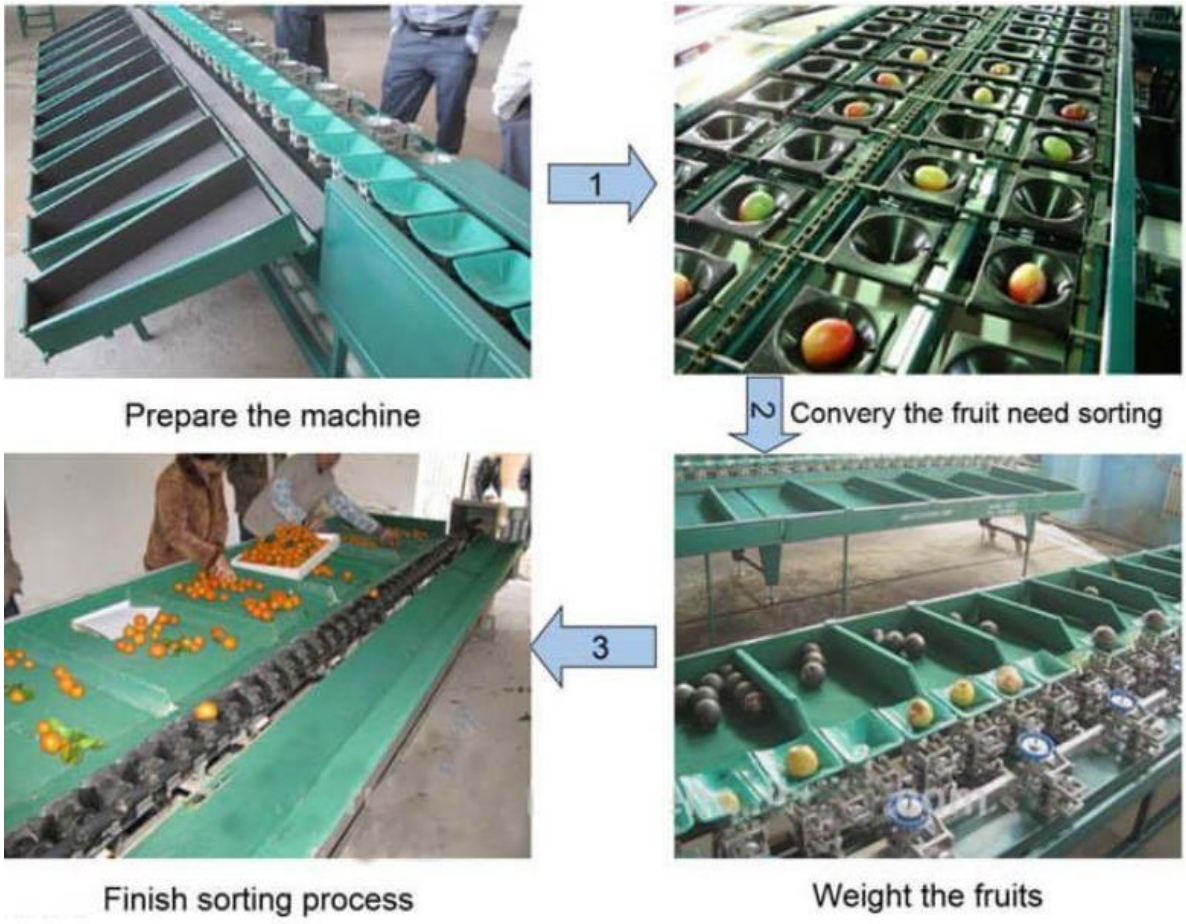


Figure 2.2 Automated Fruit Grading Machine

Figure 2.3 Automatic Fruit Grading Machine

2.3 RELEVANT TECHNOLOGY/TECHNIQUES, SENSORS

- Modular Camera with various resolutions.
- Deep Learning for recognition of capsicum.
- Automated grading system
- The Blizzard free fall pulse LED camera sorting machine Technology, Intuitive Graphical user interface
- There are some new X-ray technologies that efficiently inspect whole potatoes and other vegetables and detect contaminants such as stones, glass and other foreign objects, as well as hollow hearts, ensuring safety and quality.
- The Fruit Sorting Machine adopts balance and lever principle
- K-means clustering segmentation, Histogram equalization, pre-processing technique
- Piezoresistive force sensors, K-Nearest Neighbor (KNN) approaches and Support Vector Machine (SVM)

2.4 PUBLISHED WORK FROM SOURCES AND JOURNALS:

- Grading and sorting of apple by using image processing by K. Apeksha, P. Pornima, P. Sudarshan, Prof. Salunkhe K.D published in International Research Journal of engineering and technology (IRJET).
- Fruits grading and sorting classification algorithm using colors abd shape features by Abdulrahman S. Alturki, Muhammed Islam, Mohammed F. Alsharekh, Mohammed S. Almanee and Anwar H. Ibrahim published in International Journal of Engineering Research and technology ISSN 0974-3154.
- A review of different methods of grading for fruits and vegetables by Londhe D, Nalawade, Sachin, Pawar G, Atkari, V, Wandkar, Sachin published in Agricultural Engineering International: CIGR Journal
- Tomra
- QTechnology (https://qtec.com/industries-applications-food-grading/)
- Automated Sorting And Grading of Vegetables Using Image Processing by Dr.S.USHA , Dr.M.KARTHIK , R.JENIFER3 1,2 Associate Professor (Senior Grade),Department of EEE, Kongu Engineering College, India
- Bandyopadhyaya I., Babu D., Bhattacharjee S., Roychowdhury J. (2014) Vegetable Grading Using Tactile Sensing and Machine Learning. In: Kumar Kundu M., Mohapatra D., Konar A., Chakraborty A. (eds) Advanced Computing, Networking and Informatics- Volume 1. Smart Innovation, Systems and Technologies, vol 27. Springer, Cham.

CHAPTER 3

HARDWARE AND SOFTWARE REQUIREMENTS

Below are the mentioned Functions and Sub – Functions for the designing and implementing of the project. And the interconnection between these identified functions and sub-functions is shown in the Figure 3.1.

3.1 FUNCTIONS

- Control unit
- Actuator
- Material
- Camera
- Belt
- Drive mechanism

SUB-FUNCTIONS

- Intake of power from DC source
- Transmission of power to the system
- Transmit the data to the program
- Process the data received
- Feedback of work done.

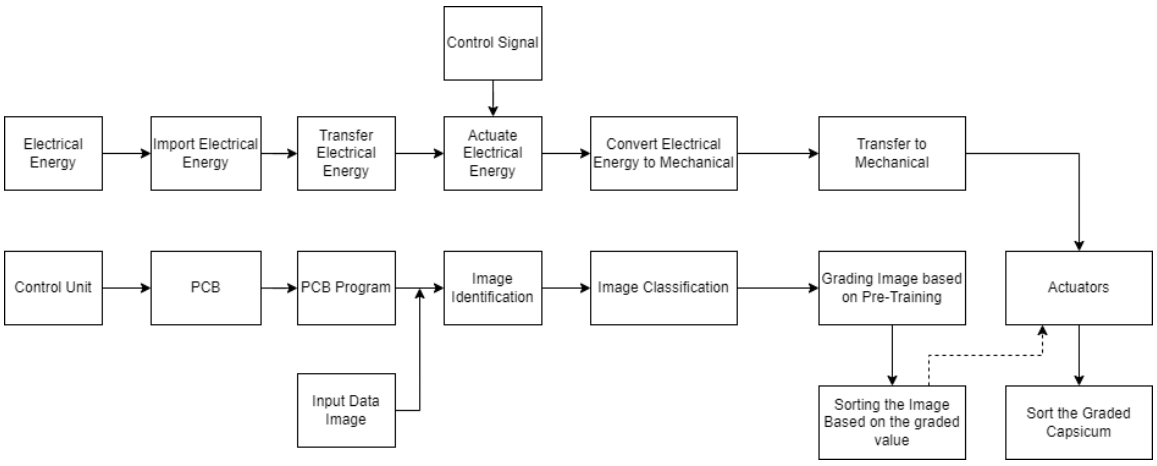


Figure 3.1 Function Diagram

3.2 RESOURCES IDENTIFIED FOR IMPLEMENTING EACH OF THE FUNCTIONS IN TERMS OF HARDWARE AND SOFTWARE

- Battery
- Wires
- High Resolution Camera
- Micro Computer (Raspberry Pi,)
- Motors
- Belt
- Rollers

3.3 REQUIREMENT MODEL

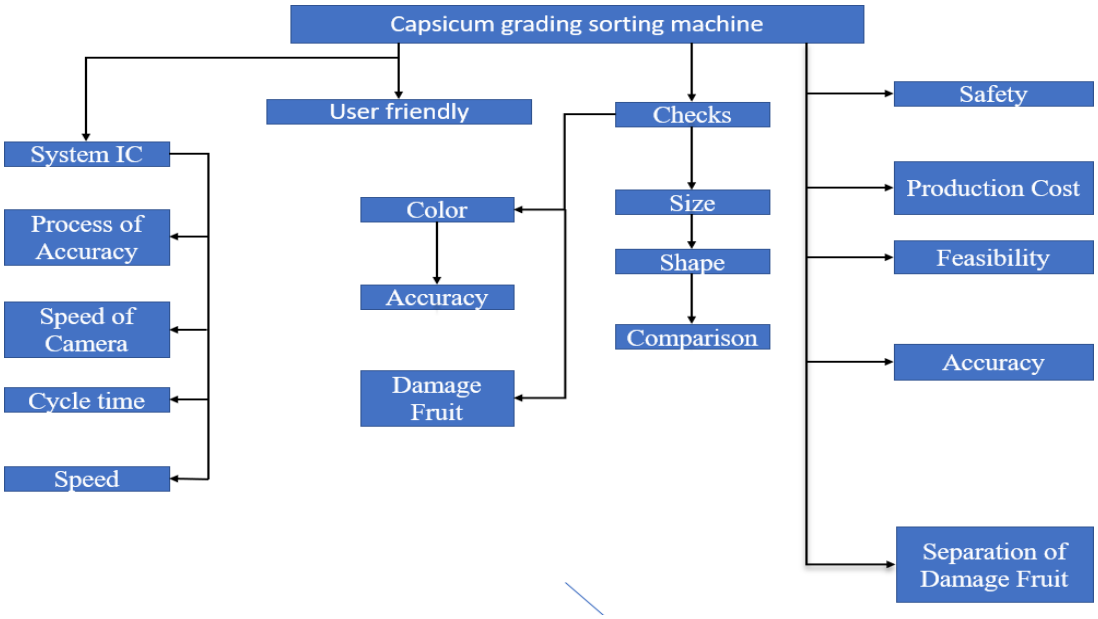


Figure 3.2 Requirement Modelling diagram

3.4 SOFTWARE REQUIREMENTS

- Soildworks
- Proteus
- ROS

3.5 HARDWARE REQUIREMENTS

- Raspberry pi 4
- L298n
- DC Motors
- 32 GB SD Card
- Jumper Wires
- Adapter 12V,2A

3.6 LANGUAGES USED

- Python

CHAPTER 4

SYSTEM DESIGN

4.1 BLACK BOX

The below is the figure showing the basic inputs and outputs of the system being developed. The basic input of any system being developed is electrical energy, apart from it we give the input data to the system and then process the data to acquire the required output results. The input data is the pre-trained model and the input picture of the capsicum vegetable which is to be classified as a fresh one or the stale ones. And after all the processing is done, we have the vegetable being graded and sorted as per requirement. As we have actuators attached for movements from one position to the other. Obviously, there is noise and heat energy dissipated from the system.

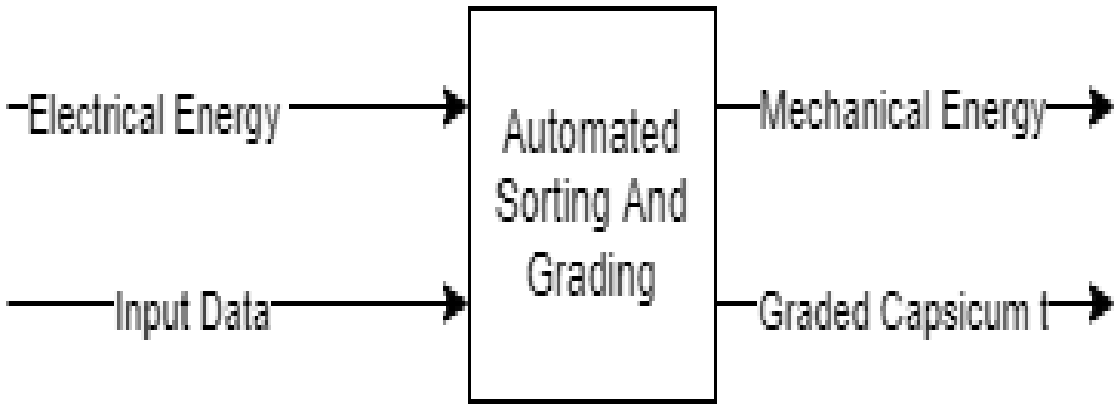


Figure 4.1 Black Box

4.2 ACTIVITY DIAGRAM

Below is the figure, showing all the activities, tasks and jobs performed by the system in depth. We have totally four units in our system Power, Processing, Interface and the Storage units. Each unit performs different task assigned to it by the user. The power unit is to provide the electrical energy to other units for its functioning. The processing unit is the point where the microcontroller captures the frames and converts it into the image and the processes the image for its classification and predicts the result accordingly. The storage unit is for storing the images and dataset as well as the pretrained model saved for further processing in real-world frame.

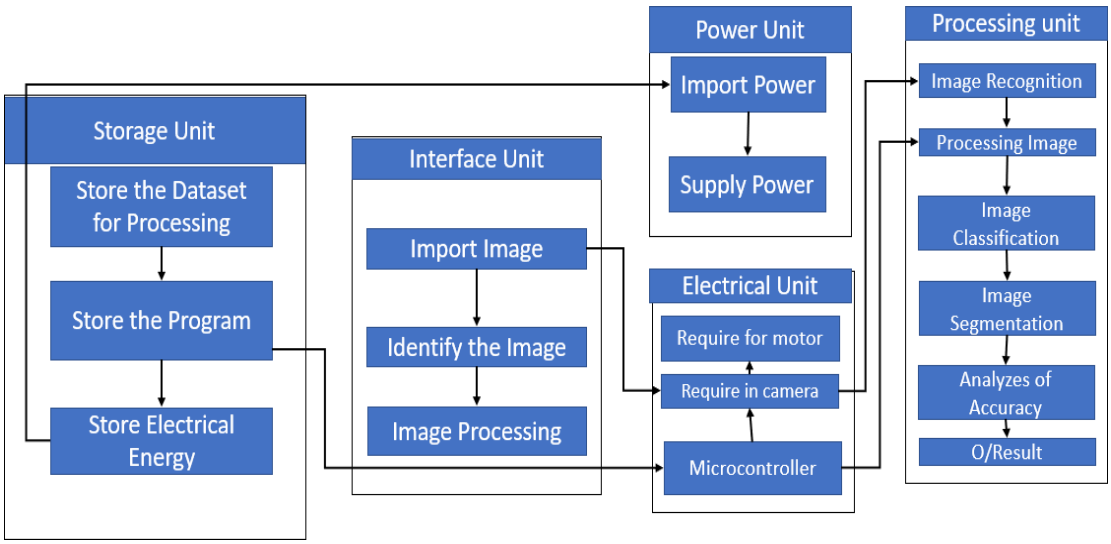


Figure 4.2 Activity Diagram

4.3 FLOWCHART OF THE PROCESSES

Every project implementing on the software process, needs an sequence of instructions to be done in a proper order. So, flowcharts are an essential figure which helps any user to understand the software phase of any device its running as well as the processing it is doing in the backend frame of the system.

Similarly, we have the flowchart designed for our systems process. It is as shown below in the figure. The process starts from capturing the image from the frames captured by the webcam and further proceeds by processing the picture and predicts an output for the input that is captured image in this context and stops there. This process occurs with every new image being captured and predicting results on it.

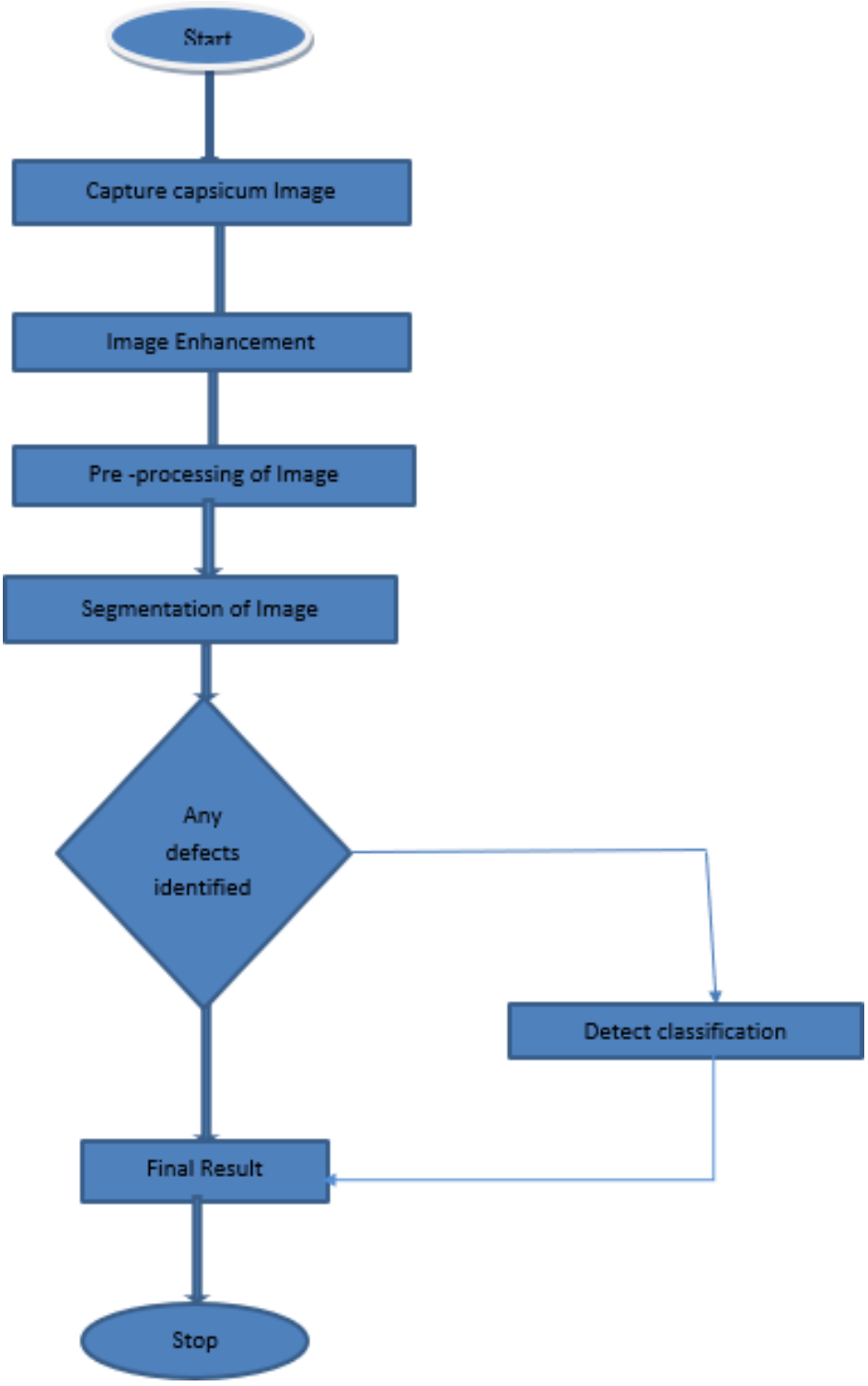


Figure 4.3 Flowchart

4.4 USE CASE DIAGRAM

A use case outline is utilized to address the powerful conduct of a framework. It exemplifies the framework's usefulness by fusing use cases, entertainers, and their connections. It displays the assignments, administrations, and capacities needed by a framework/subsystem of an application. It the significant level usefulness of a framework and furthermore tells how the client handles a framework[13].

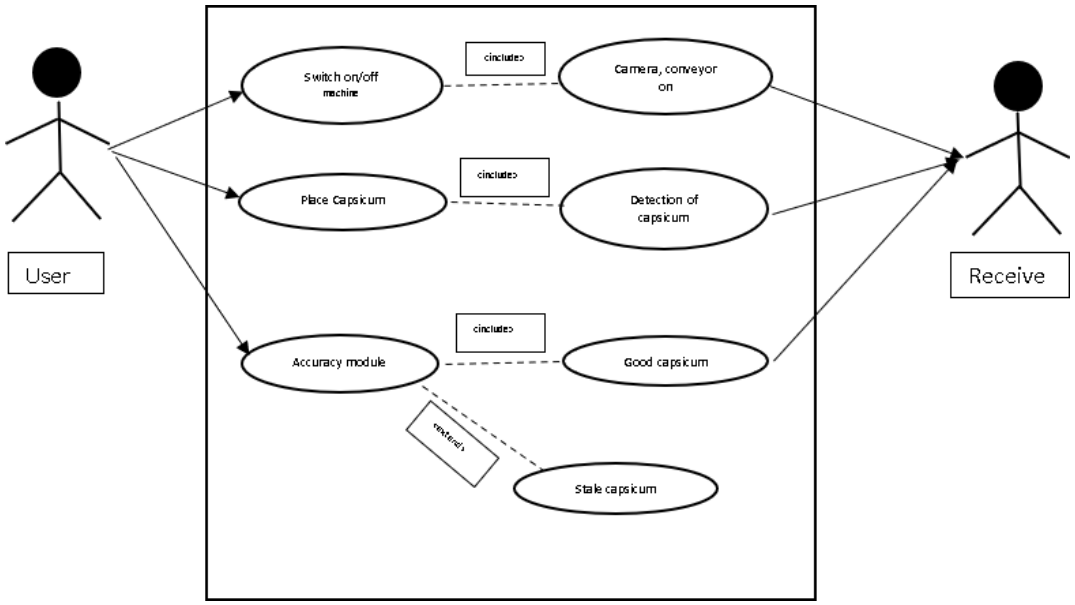


Figure 4.4 Use Case Diagram

CHAPTER 5

ARCHITECTURE OF THE SYSTEM

This Phase explains the architecture used in this project. This illustrates the correctness of the project, which means whether it is satisfying the user requirements and does it hold the requirement specification as mentioned. It enables us to correct, if any error occurs.

5.1 CONVOLUTION NEURAL NETWORK (CNN)

CNN is a deep neural network initially intended for picture examination. As of late, The CNN likewise has a magnificent limit in sequent information examination, for example, regular language handling. CNN consistently contains two fundamental activities, to be specific convolution and pooling. The convolution activity utilizing numerous channels can separate highlights (include map) from the informational collection, through which their relating spatial data can be protected. The pooling activity, likewise called subsampling, is utilized to decrease the dimensionality of element maps from the convolution activity. CNN has a wide assortment of utilizations in different fields. The main layer is the convolution layer. Convolutional layer is the essential structure square of CNN. It extricates the significant level highlights from the info signal. The pooling layer is trailed the convolution layer. The pooling tasks are fixed by the applications. The diverse pooling activity incorporates max-pooling, min-pooling, and the normal pooling. Pooling activity is basically utilized for the dimensionality decrease and furthermore to choose the main element. These elements are taken care of to the completely associated layer which comprises of initiation work [7].

5.2 CONVOLUTION NEURAL NETWORK METHOD

Convolutional Neural Network is an exceptional technique. It joins division, include extraction and grouping in one handling module. A large portion of CNN configuration is gotten from LeNet-5. LeNet-5 comprises of 7 layers that is shaped by 4 element extraction layers and 3 layers of MLP. Include of extraction layer comprises of convolution and subsampling layers. Convolution layer eliminates clamor and recognize lines, lines or corners of a picture. In subsampling layer, it lessens the goal of a picture to forestall picture

twists. CNN has inherent invariance when contrasted with ordinary neural organization (MLP). CNN is predominant in creating high precision in recognizable proof cycle albeit the calculation is mind boggling. In preparing the organization, LeNet-5 applies Stochastic Slanting Levenberg Marquardt (SDLM) learning calculation. Not at all like other neural organization, when other complex information base is applied, the framework needs to go through negligible updating process.

5.3 MobileNet_v1 Architecture

We present a class of effective models called MobileNets for versatile and inserted image processing applications. MobileNets depend on an improved design that utilizes profundity detachable curls to fabricate profound and lightweight neural organizations. We present two simples worldwide hyperparameters that productively balance idleness and accuracy. These hyperparameters permit the modeler to pick the right model for his application dependent on the limitations of the issue. We present broad analyses on accuracy and asset compromises and show hearty execution contrasted with other well-known models in the ImageNet positioning. We then, at that point, showed the adequacy of MobileNets in a wide assortment of utilizations and use cases, including object identification, fine-grainedarrangement, facial highlights, and enormous scope geolocation [8].

In this undertaking we are chipping away at with MobileNet engineering, which is a Convolutional Neural Organization (CNN) design. This model is extremely lightweight model and is assembled utilizing profundity shrewd distinguishable convolutions.

The Mobile Net Organization engineering is a unique class of convolutional neural models that are constructed utilizing profundity divisible convolutions and hence are lighter as far as their number of boundaries and computational intricacy. Moreover, the creators associated with the advancement of this organization engineering presented 2 extra worldwide hyperparameters. These are the width and goal multiplier which can handle the quantity of information/yield channels of the convolution layers and the information goal (i.e., stature, width) individually. These boundaries can be utilized to straightforwardly impact network idleness versus precision, contingent upon end-client necessities [11].

Table 5.1 MobileNet Body Architecture

Type/Stride	Filter Shape	Input Size
Conv/s2	3x3x3x32	224x224x3
Conv dw /s1	3x3x32 dw	112x112x32
Conv/s1	1x1x32x64	112x112x32
Conv dw/s2	3x3x64 dw	112x112x64
Conv /s1	1x1x64x128	56x56x64
Conv dw/s1	3x3x128 dw	56x56x128
Conv/s1	1x1x128x128	56x56x128
Conv dw/s2	3x3x128 dw	56x56x128
Conv/s1	1x1x128x256	28x28x128
Conv dw/s1	3x3x256 dw	28x28x256
Conv/s1	1x1x256x256	28x28x256
Conv dw/s2	3x3x256 dw	28x28x256
Conv/s1	1x1x256x512	14x14x256
5xconv dw/s1 Conv/s1	3x3x512 dw 1x1x512x512	14x14x512 14x14x512
Conv dw/s2	3x3x512dw	14x14x512
Conv/s1	1x1x512x1024	7x7x512
Conv dw/s2	3x3x1024dw	7x7x1024
Conv/s1	1x1x1024x1024	7x7x1024
Avg Pool/s1	Pool 7x7	7x7x1024
FC/s1	1024x1000	1x1x1024
SoftMax/s1	Classifier	1x1x1000

5.4 Elements of MobileNet_V1

- **Grouped Convolution**

  Gathered convolution is a variation of convolution where the channels of the information include map are assembled and convolution is performed freely for each assembled channel. Allowing G to mean the quantity of gatherings, the computational expense of assembled convolution is $HWNK^2M/G$, bringing about 1/G decrease in computational expense contrasted and standard convolution.

- **Depthwise Convolution**

  In Depthwise convolution, convolution is performed independently on each of input channels. Here is a special case of group of convolutions where the numbers of inputand output channels are same and here G equals the number of channels.

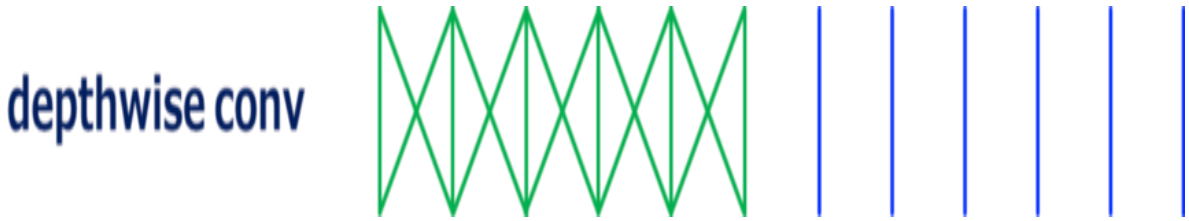


Figure 5.1 Depthwise Convolutional Network

As shown above, Depthwise convolution significantly reduces the computational cost by omitting convolution in channel domain [2].

MobileNet [6] uses a module design like the leftover unit with bottleneck engineering of ResNet; the altered form of the lingering unit where convolution 3x3 is supplanted by Depthwise convolution.

As you can see from the abovementioned, as opposed to the standard bottleneck design, the first conv1x1 expands the channel aspect, then, at that point, Depthwise conv is performed, lastly the last conv1x1 diminishes the channel aspect. By reordering the structure blocks as above and contrasting it and MobileNet-v1 (detachable conv), we can perceive the way these functions.

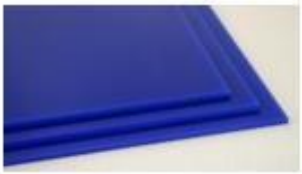
The above module be regarded as a modified version of separable convolution where the single convolution1x1 in separable convolution is factorized into two convolution1x1s. Letting T denote an expansion factor of channel dimension, the computational cost of two conv1x1s is $2HWN^2/T$ while that of conv1x1 in separable convolution is HWN^2. In [5], T = 6 is used, reducing the computational cost for conv1x1 by a factor of 3 (T/2 in general).

CHAPTER 6

DESIGN METHODOLOGY

6.1 MORPHOLOGY CHART

Table 6.1 Morphological Chart

Function	1	2	3
Control unit	Raspberry pi 4 	Nvidia 	Arduino 
Actuator	Stepper 	Servo 	Dc motor 
Material	Acrylic 	Metal 	Resin Polymer 
Camera	Raspbian pi cam 	Foxin Webcam 	
Drive mechanisms	Powered roller conveyor 	Flat Conveyor belt 	Sidewall Conveyor Belt 
Belts	Plastic modular belts 		Solid flat belt

6.2 Concept Design for Selected Problem Statement

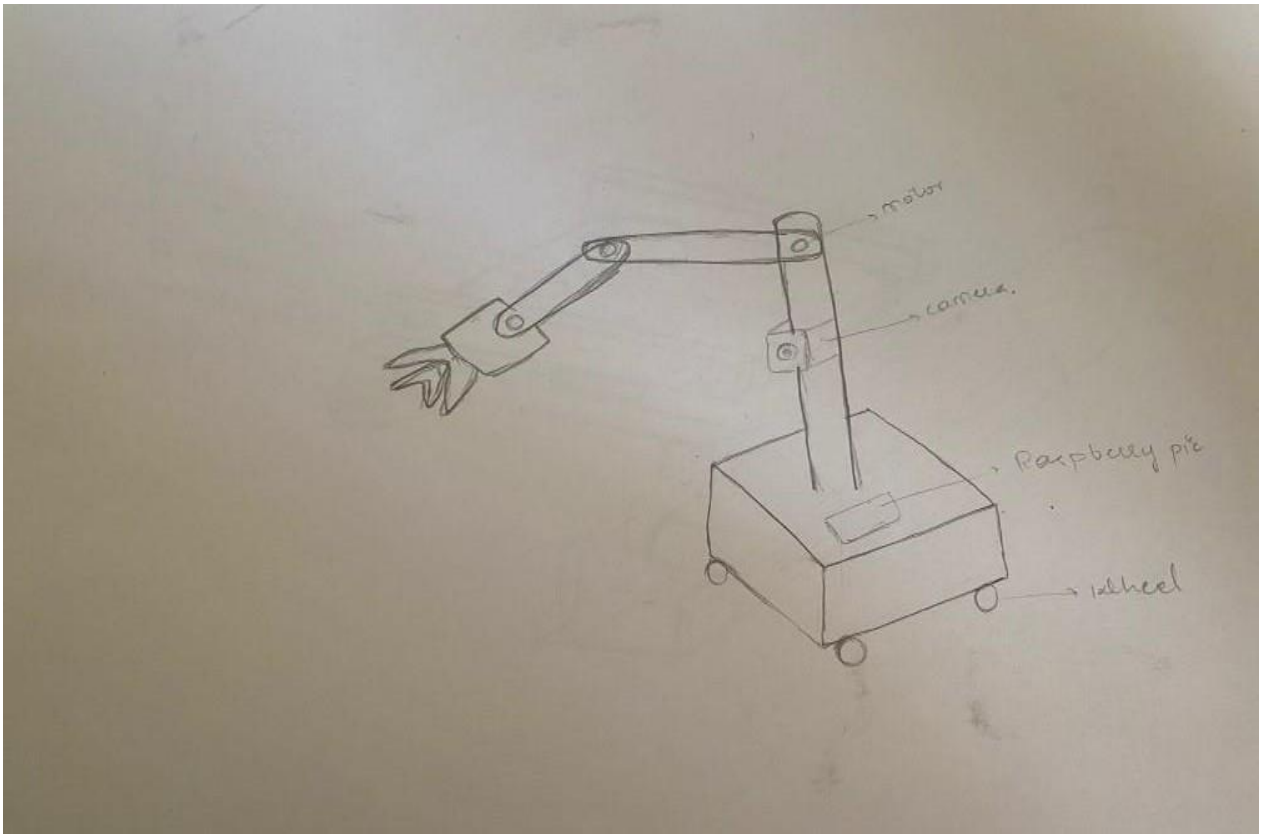


Figure 6.1 DESIGN 1

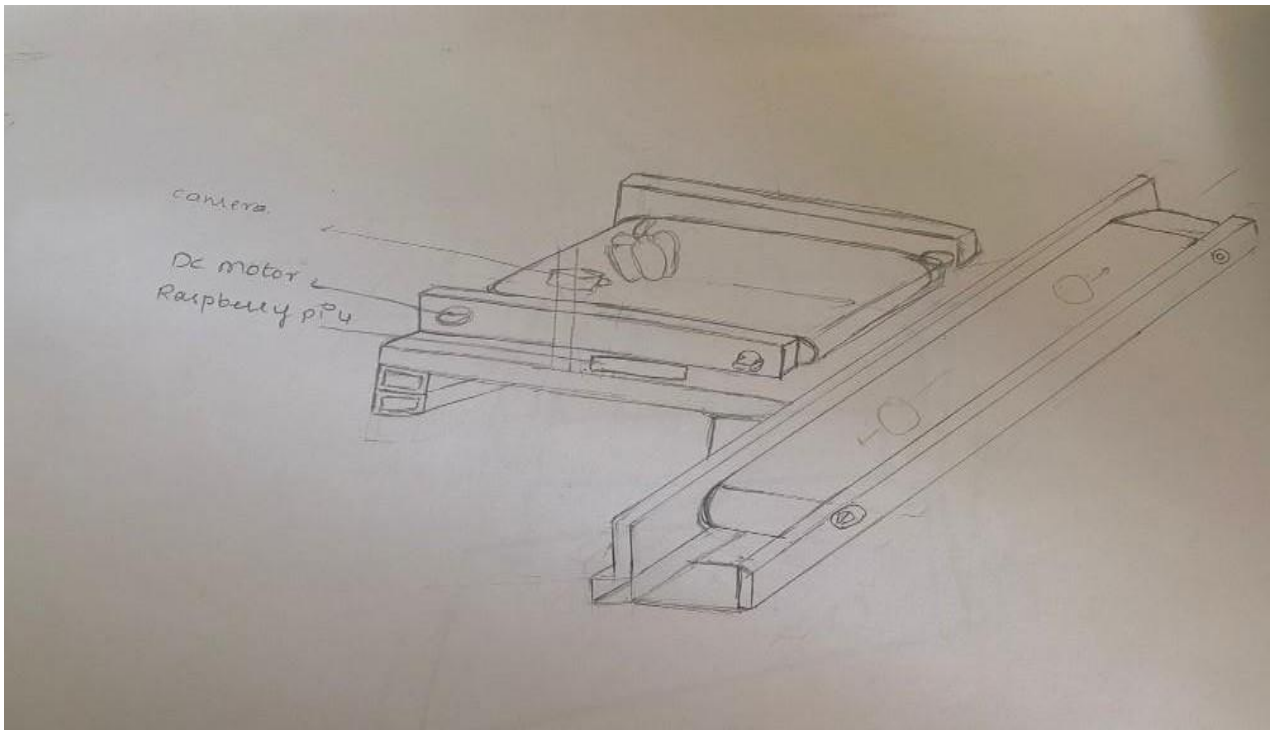


Figure 6.2 DESIGN 2 (SELECTED DESIGN)

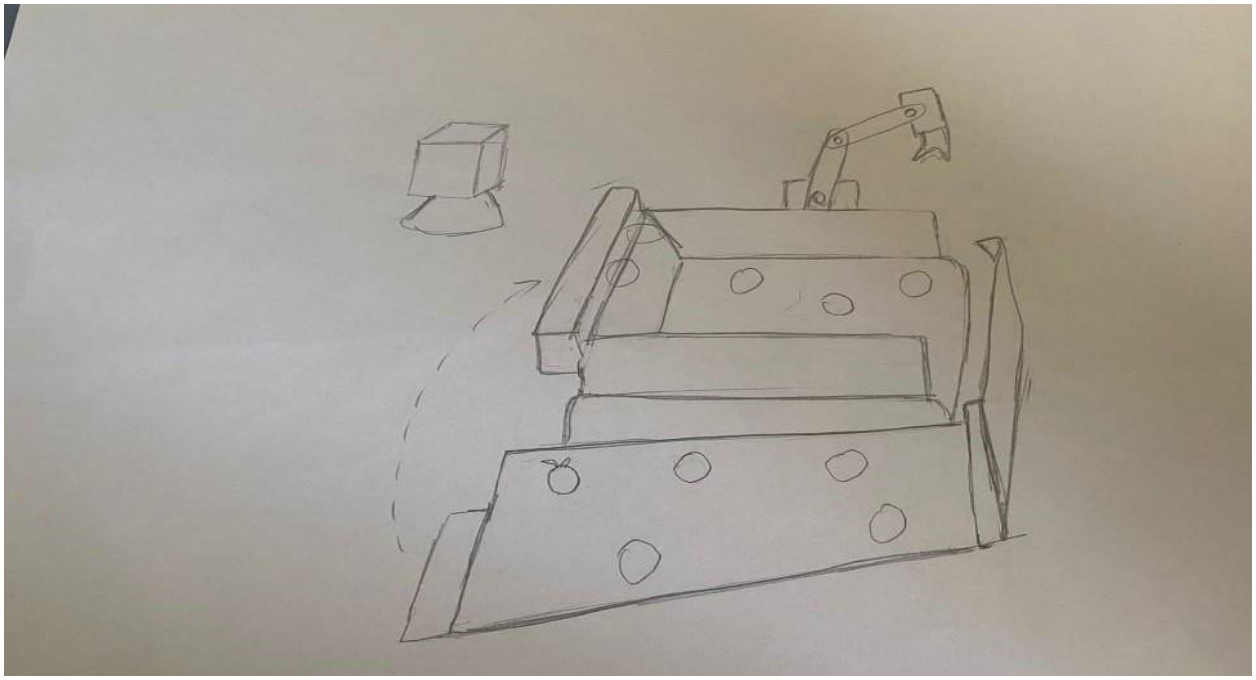


Figure 6.3 DESIGN 3

6.3 CONCEPT SCREENING AND SCORING

Table 6.2 Concept Screening

Objectives	*Design1*	*Design2*	*Design3*
Portability	+	0	0
Cost Efficiency	-	+	0
User friendly	0	+	0
Accuracy	+	++	+
Efficient	0	+	0
Pluses	2	5	1
same	2	1	4
Minuses	1	0	0
Net	3	6	5
Rank	3	1	2
Yes/No	No	yes	yes

Table 6.3 Concept Scoring

Selection criterion	**weightage**	**Solution1[Desgin2]**		**Solution2[Design3]**		**Reference**
		Rate	***Weight score***	***Rate***	***Weight score***	
Accuracy	30%	4	0.1	2	0.5	0
Portability	10%	5	0.75	3	0.45	0
Cost Efficiency	30%	3	0.75	2	0.5	0
User friendly	15%	5	0.75	4	0.6	0
Efficient	15%	4	0.8	3	0.6	0
Total	100%		3.15		2.65	0
					Selected	

6.4 DECISION MATRIX

Table 6.4 Matrix Decision

Criteria	***Alternative Solution***		
	Design1	***Design2***	***Design3***
Portability	7	5	4
Accuracy	6	8	7
Cost Efficiency	5	8	6
User friendly	6	7	8
Safe	8	9	8
Total	32	37	33

Excellent: 08-10 ***Fair:*** 05-06 ***Unsatisfactory***: 00-02

Good: 06-08 ***Poor:*** 03-04

6.5 CIRCUIT DESIGN

The circuit design is made using proteus software, the circuit design includes components like raspberry pi with Foxin camera module as shown in below figure 6.4.

Figure 6.5 shows the circuit connection of raspberry pi with Motor driver l298n and with the dc motors.

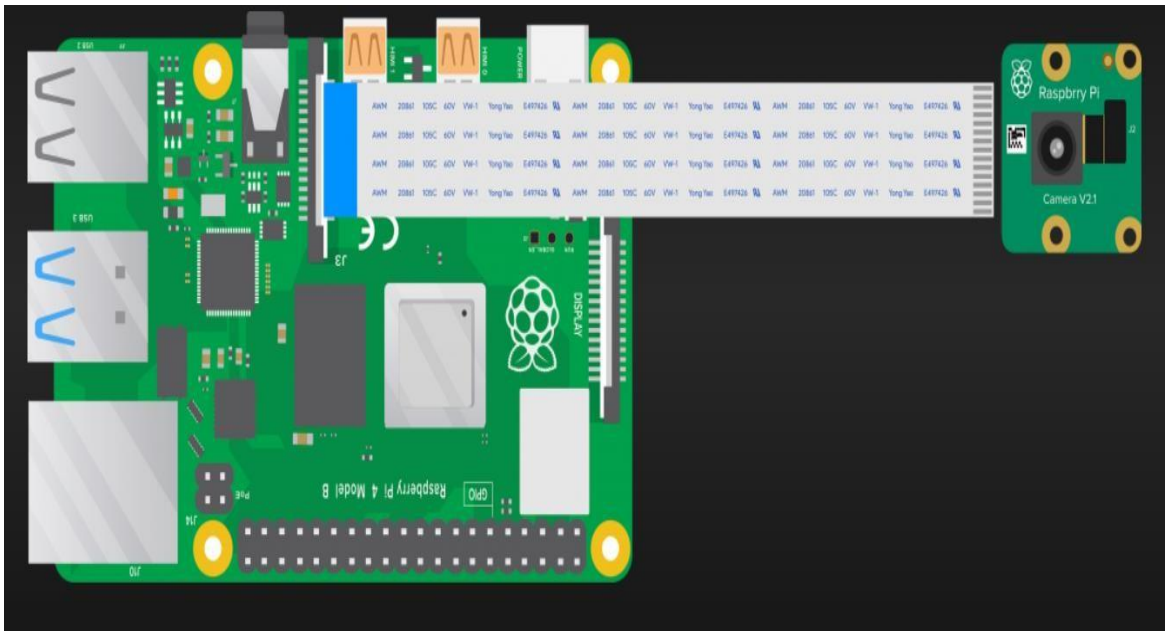


Figure 6.4 Proteus Circuit design of Raspberry Pi with Pi Cam (Foxin Cam)

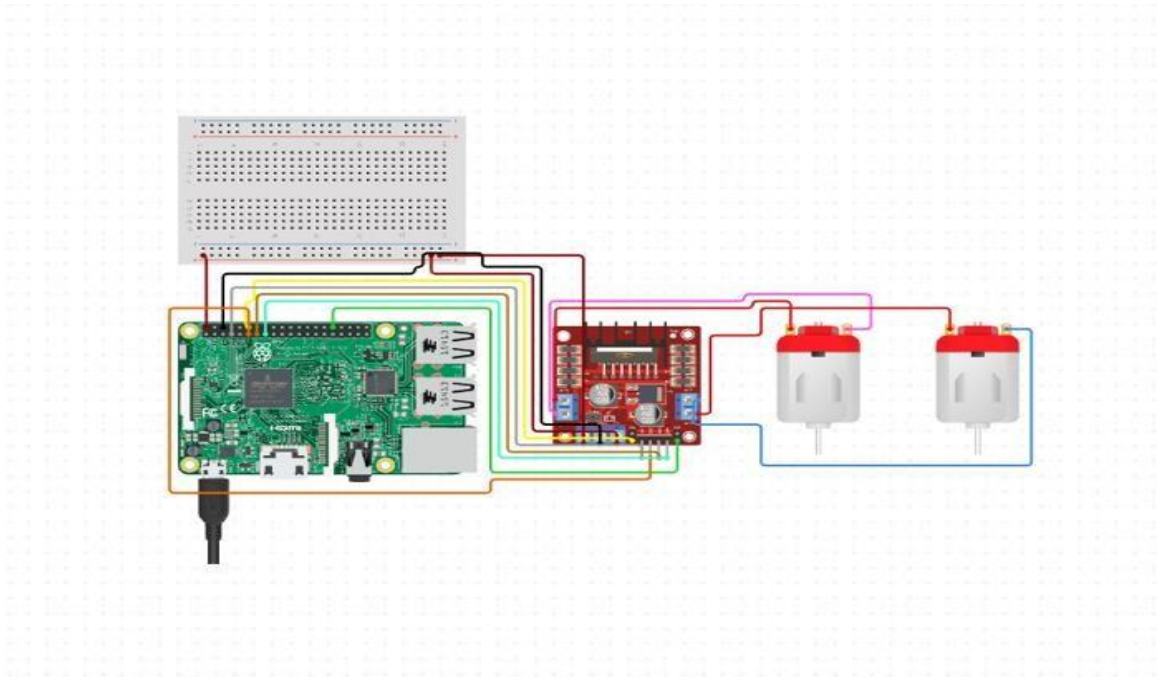


Figure 6.5 Proteus Circuit design of Raspberry Pi with L298H and two Motors

6.6 SOLODWORKS DESIGN

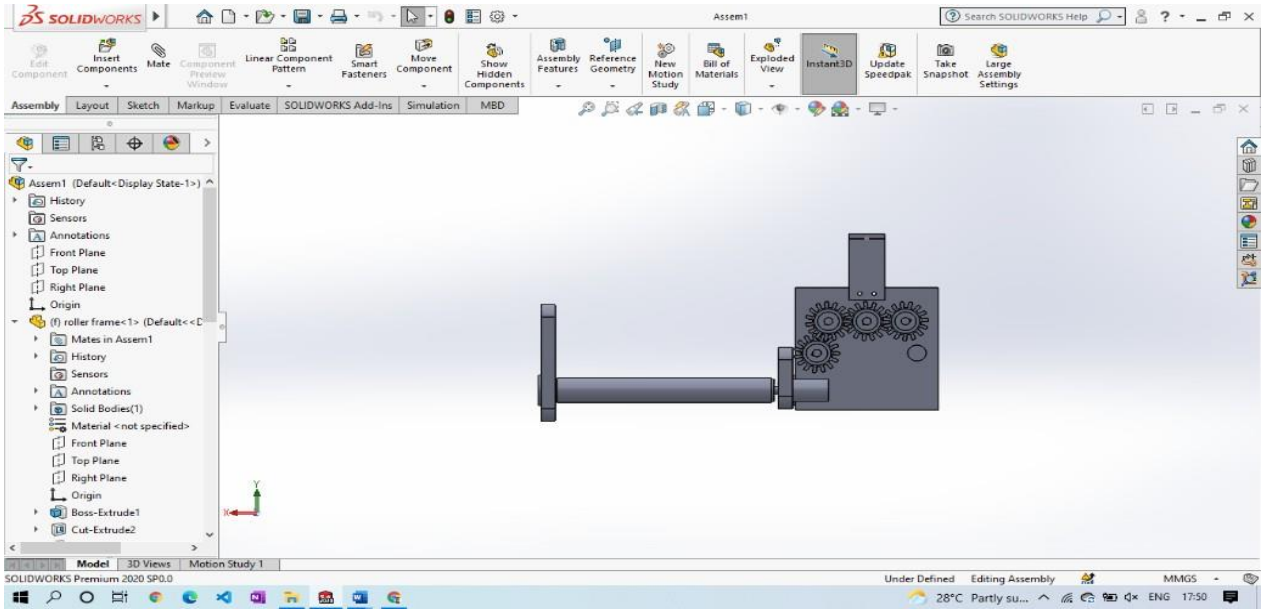


Figure 6.6 Side view of automatic capsicum sorting machine

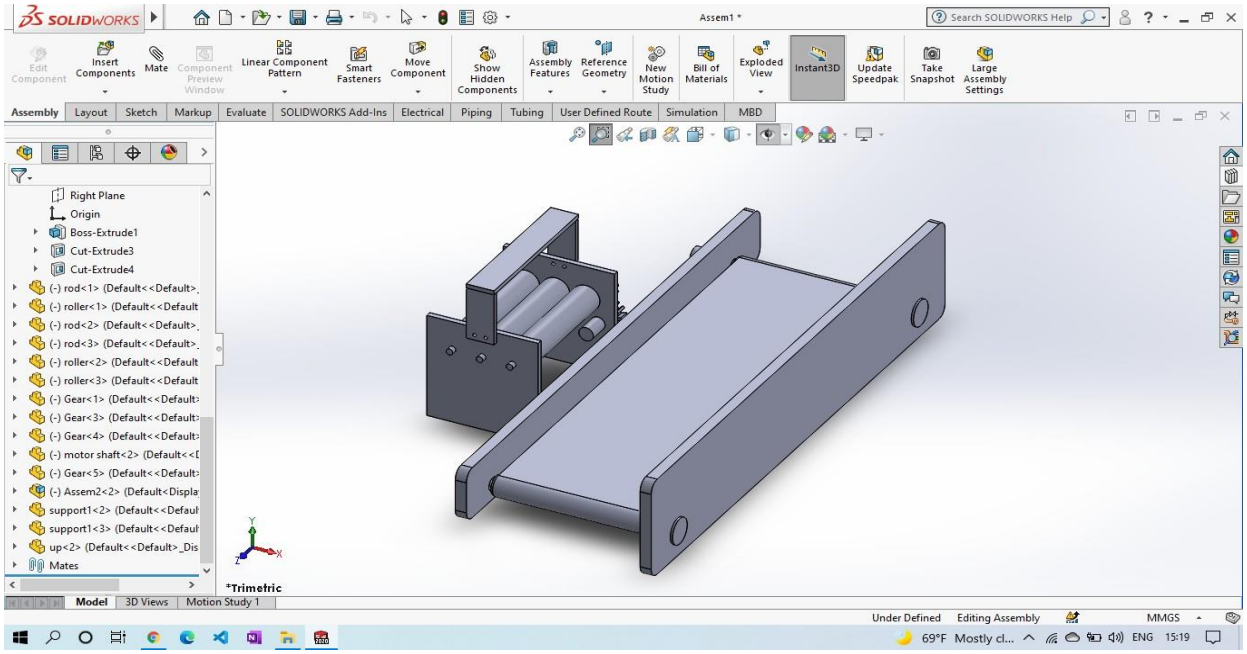


Figure 6.7 Automatic sorting Machine

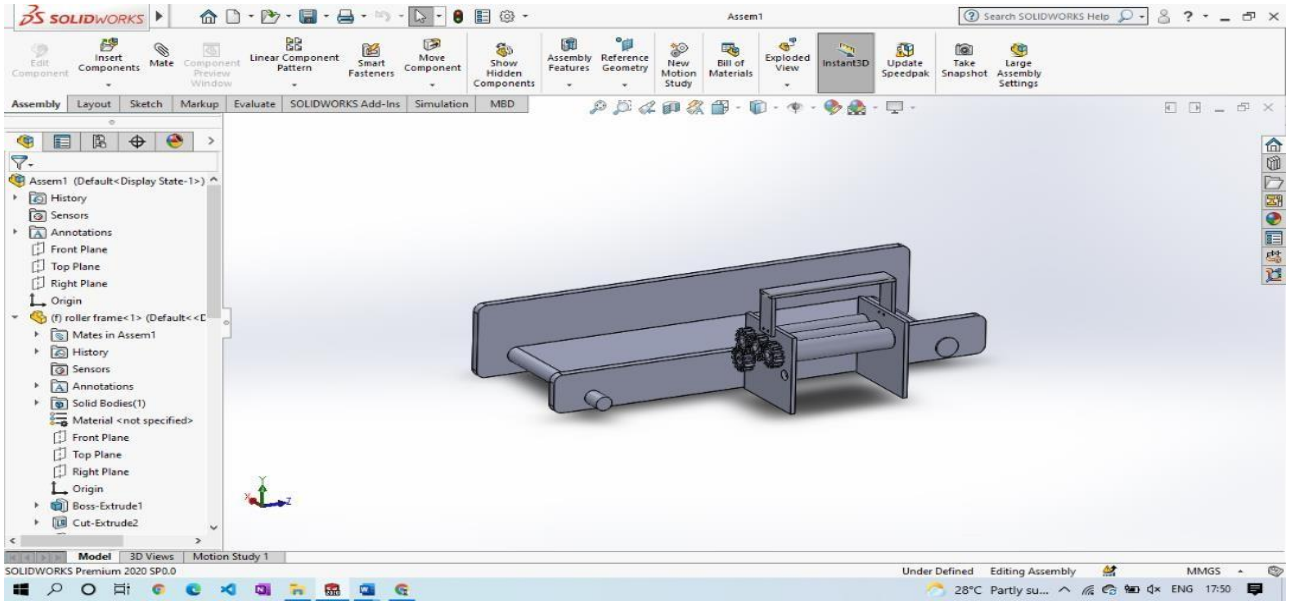


Figure 6.8 Isometric view of automatic Capsicum sorting machine.

6.7 HARDWARE SUB SYSTEMS

- Roller Conveyor with gears:

In the project we have used roller conveyor moved with power and gear train. The use of the conveyor is for the movement of the Capsicum over it, because due to its motion and rotation over the conveyor, camera can capture the images of capsicum and grade accordingly. After which the capsicum will be graded according to their freshness, and then they will be moved to another conveyor where they get sorted accordingly.

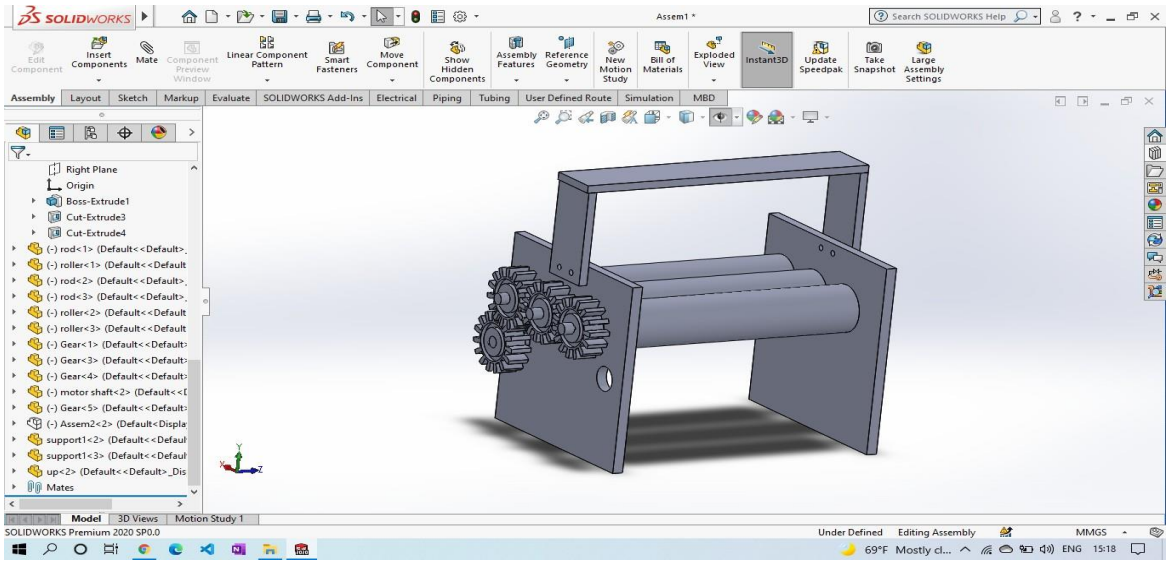


Figure 6.9 Roller Conveyor

- Belt conveyor:

The belt conveyor is used for the sorting of capsicum that have been graded before. The sorting is done considering one factor of weather the capsicum is fresh or stale. The conveyor moves in both the direction for sorting the two types of capsicum where they are collected in the container.

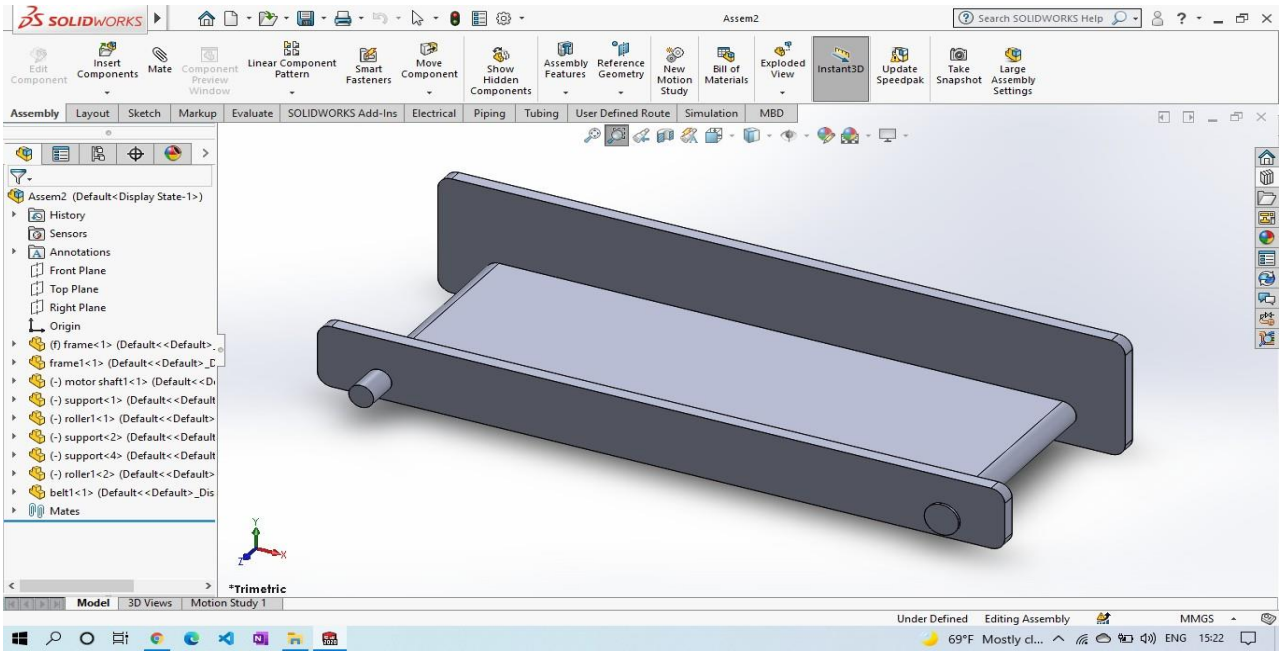


Figure 6.10 Belt Conveyor

- Gear train:

There is total 5 gears used in the gear train of same number of teeth. These Gears helps in rotation of the rollers of the conveyor, in which one gear is run by the motor and remaining gears are the followers of the master gear. The gear train run by 45 rpm DC motor.

- Motors:

There are 2 motors used in this system. One motor is used for the belt conveyor which helps in rotation of conveyor in both the direction, i.e., clockwise and anti-clockwise rotation of motor with the help of L298D motor driver.

6.8 SOLODWORKS PART DESIGN

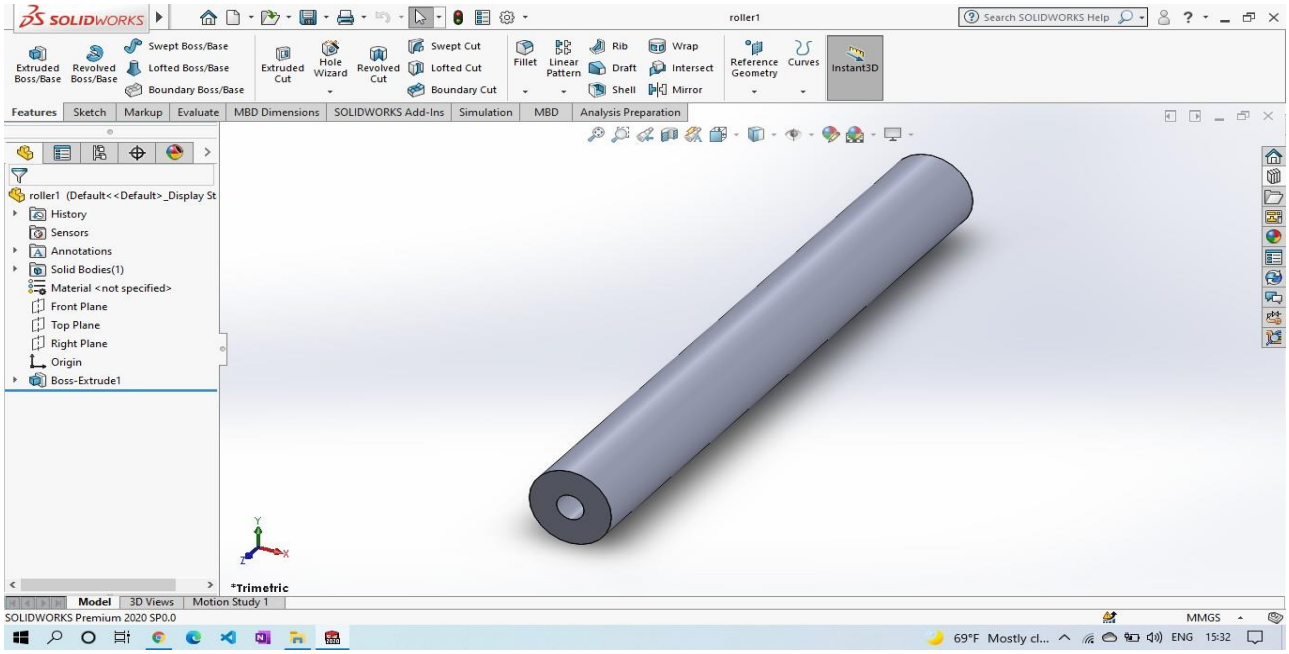


Figure 6.11 Roller Part Design

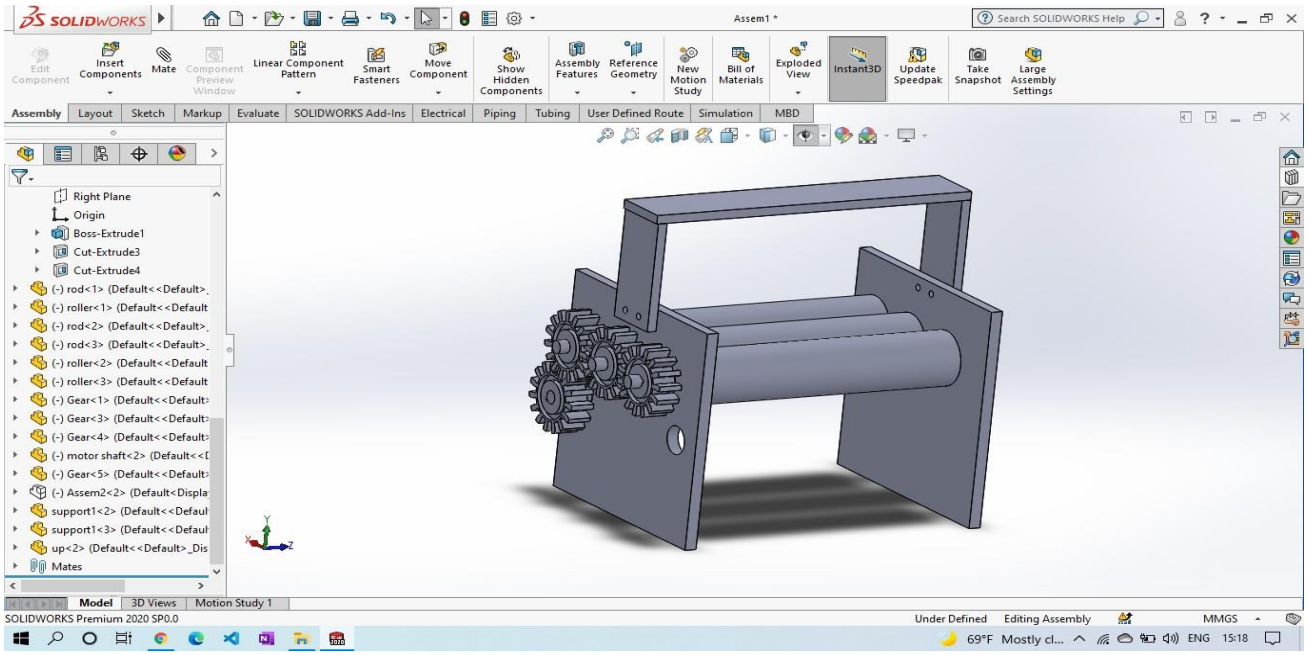


Figure 6.12 Assembly of Roller Conveyor

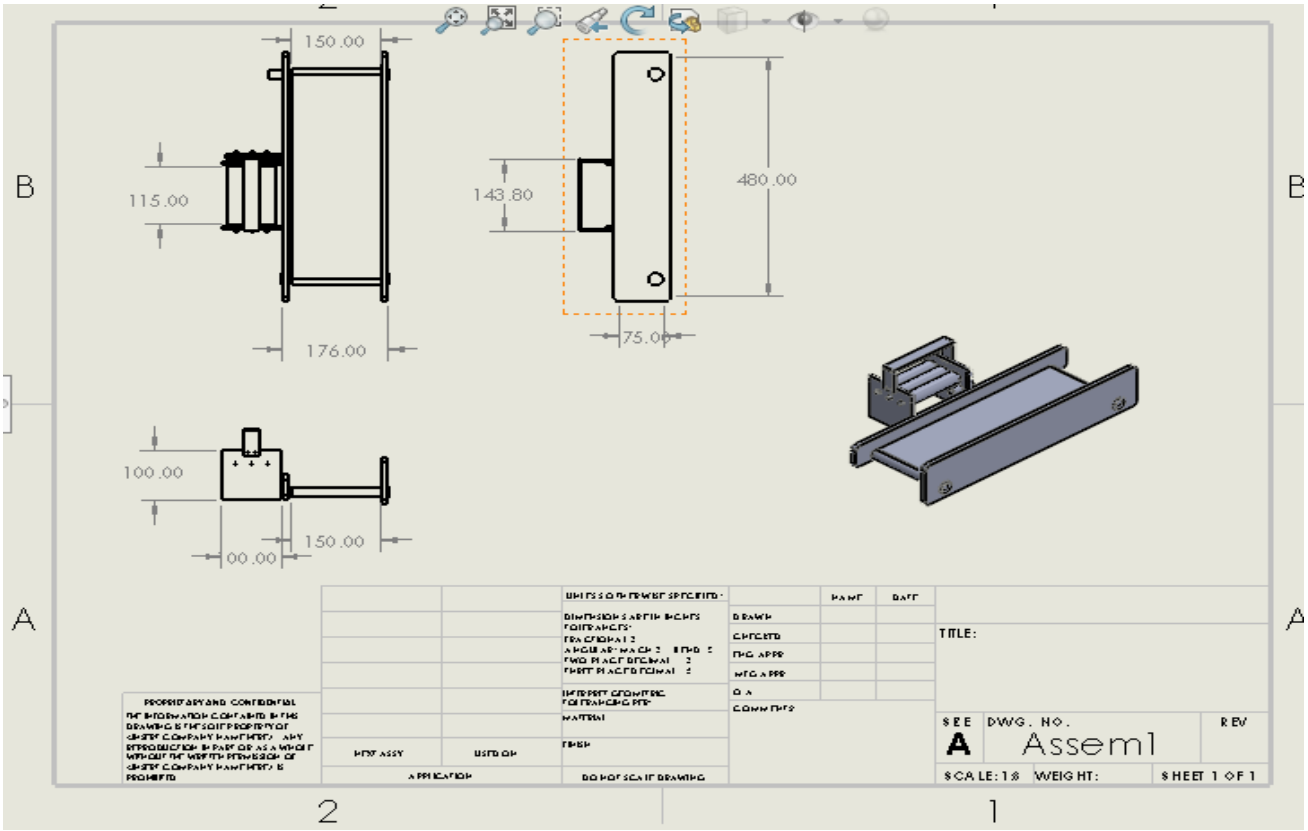


Figure 6.13 Assembly Design of Capsicum sorting Machine

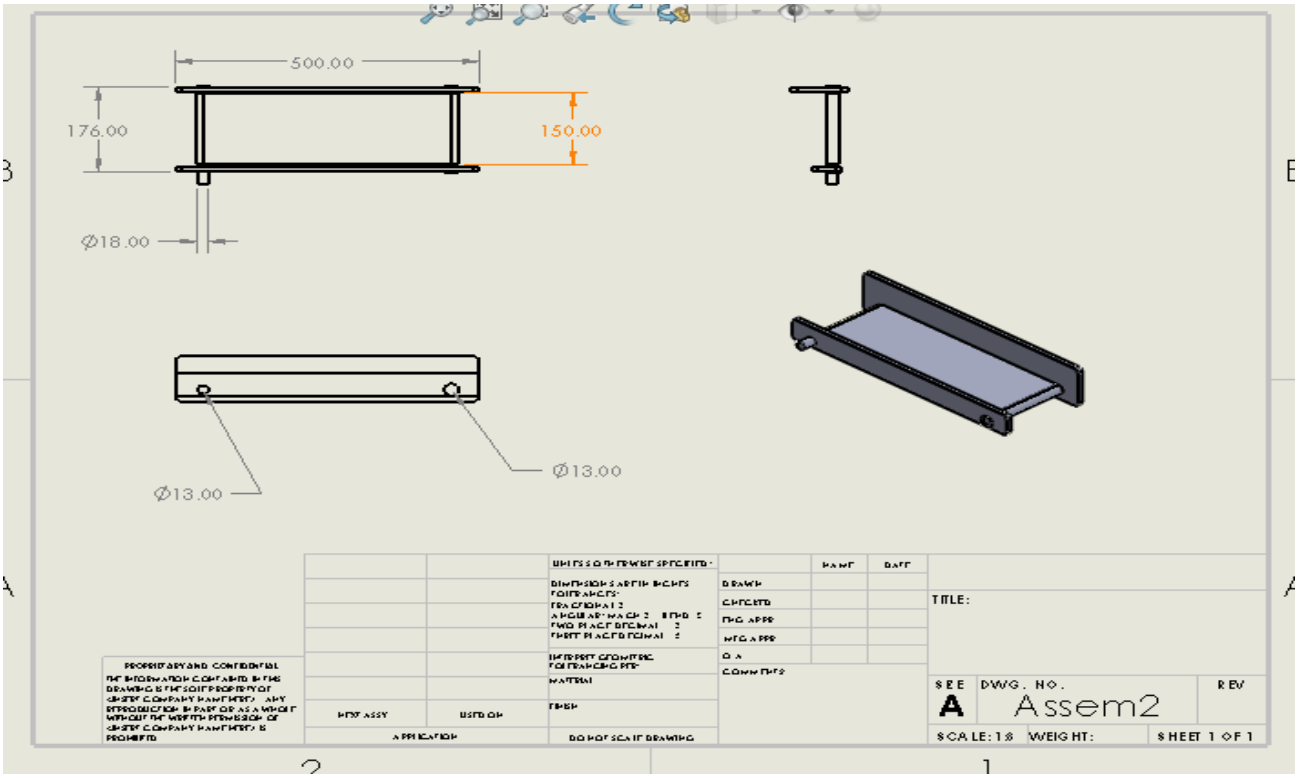


Figure 6.14 Belt Conveyor System

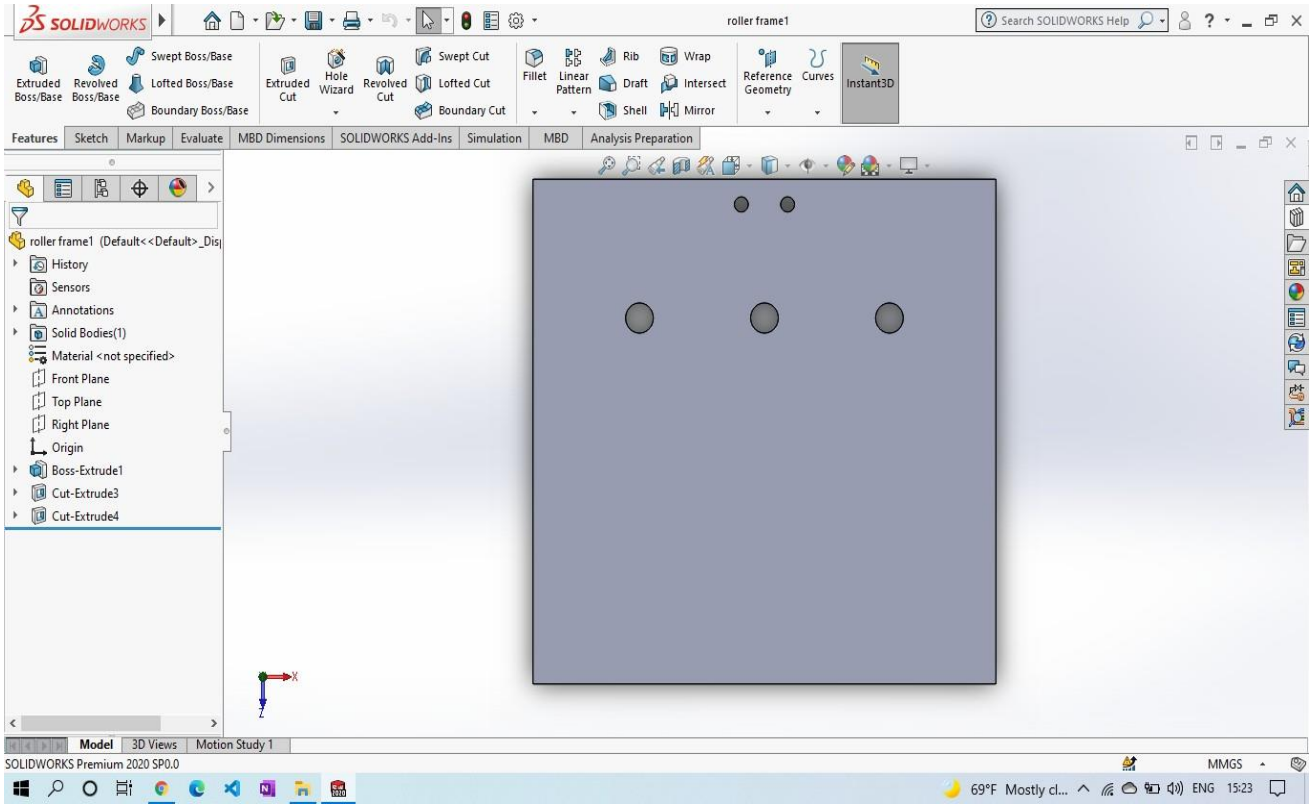


Figure 6.15 Left Side Panel of Roller Conveyor

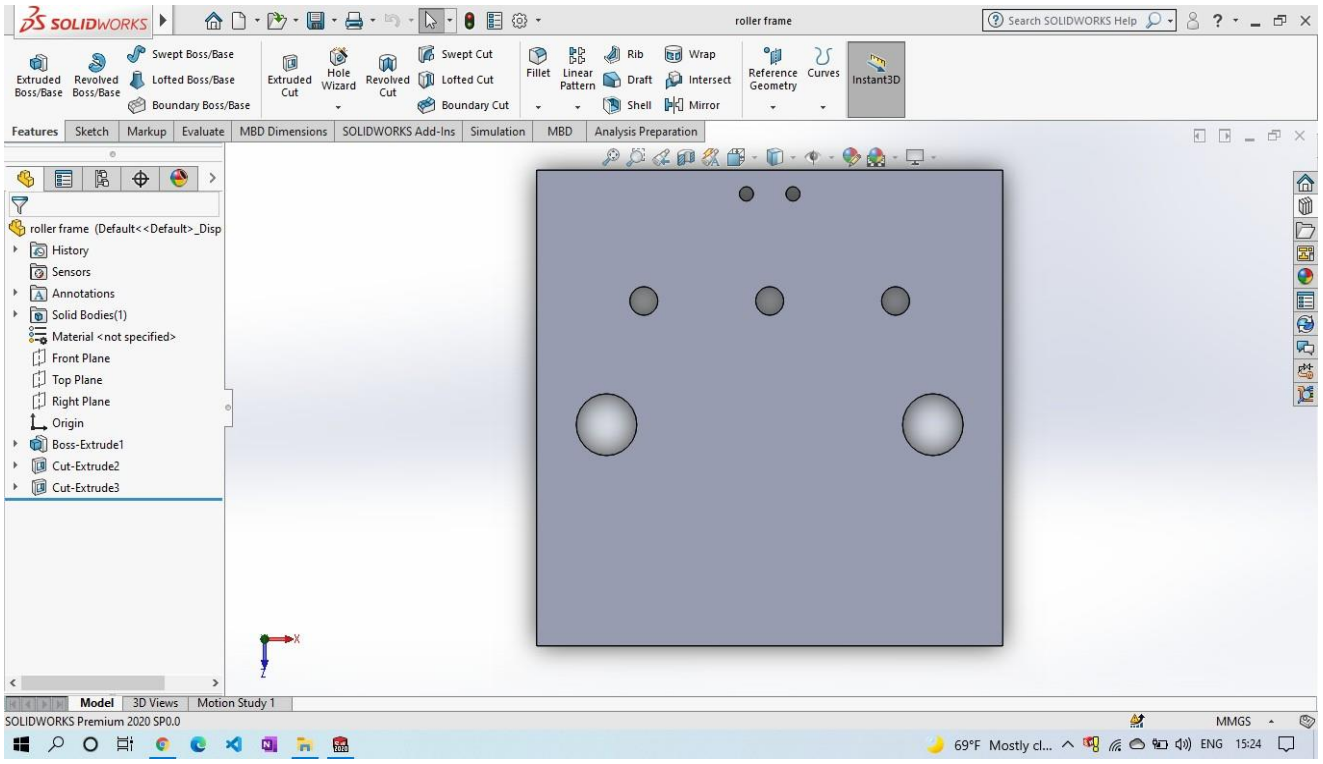


Figure 6.16 Right Panel of Roller Conveyor

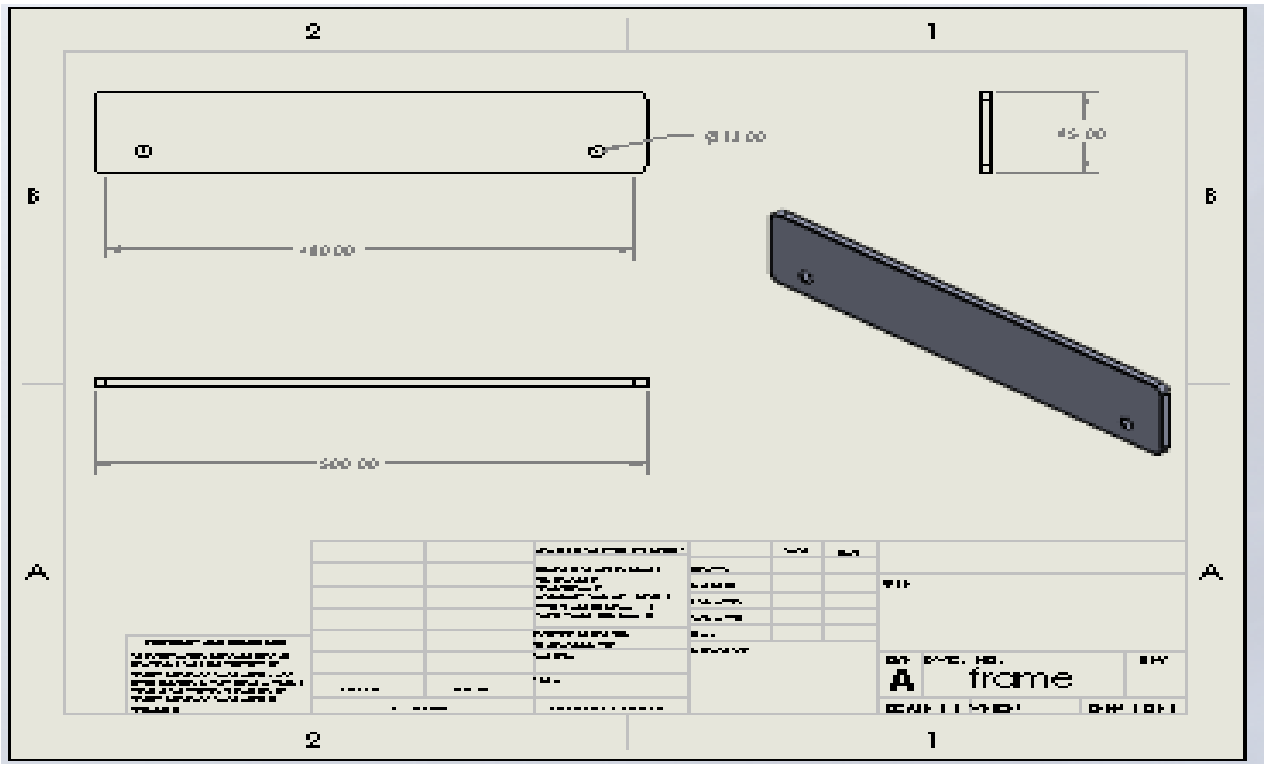


Figure 6.17 Left panel of belt conveyor

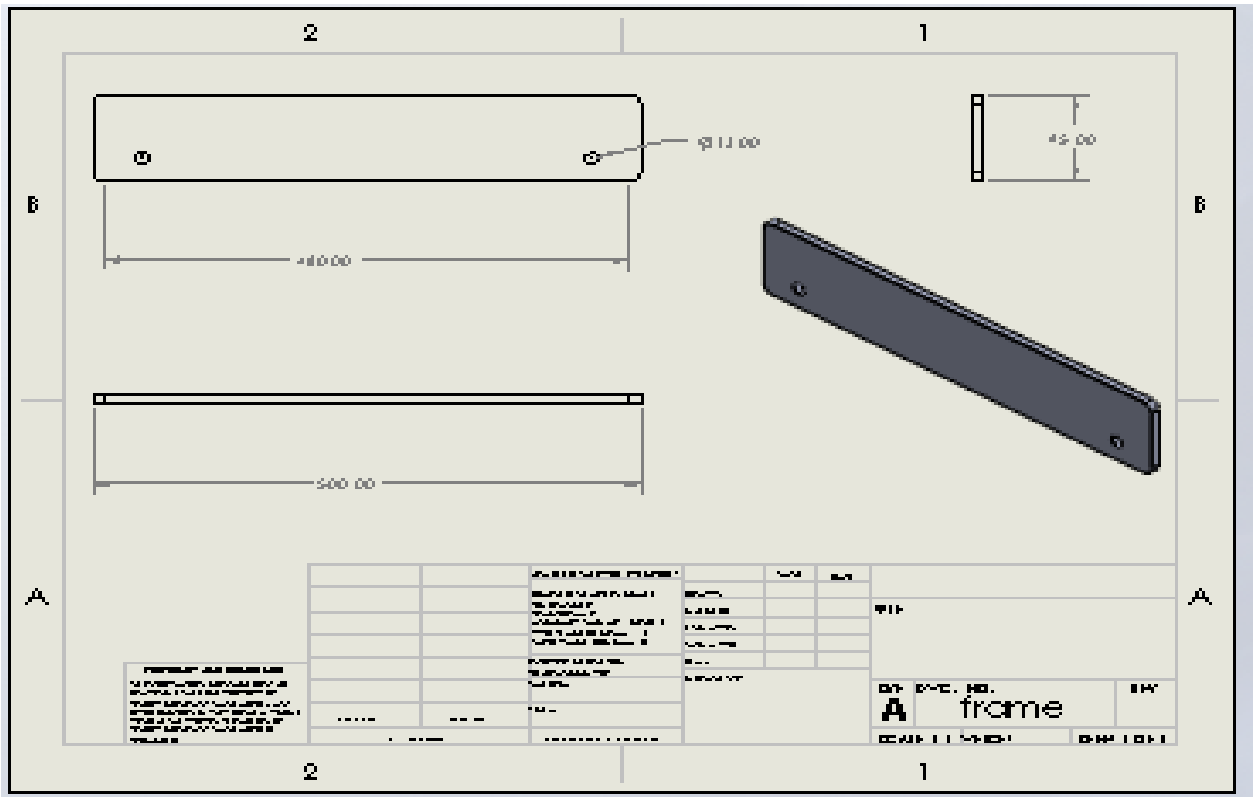


Figure 6.18 Right panel of belt conveyor

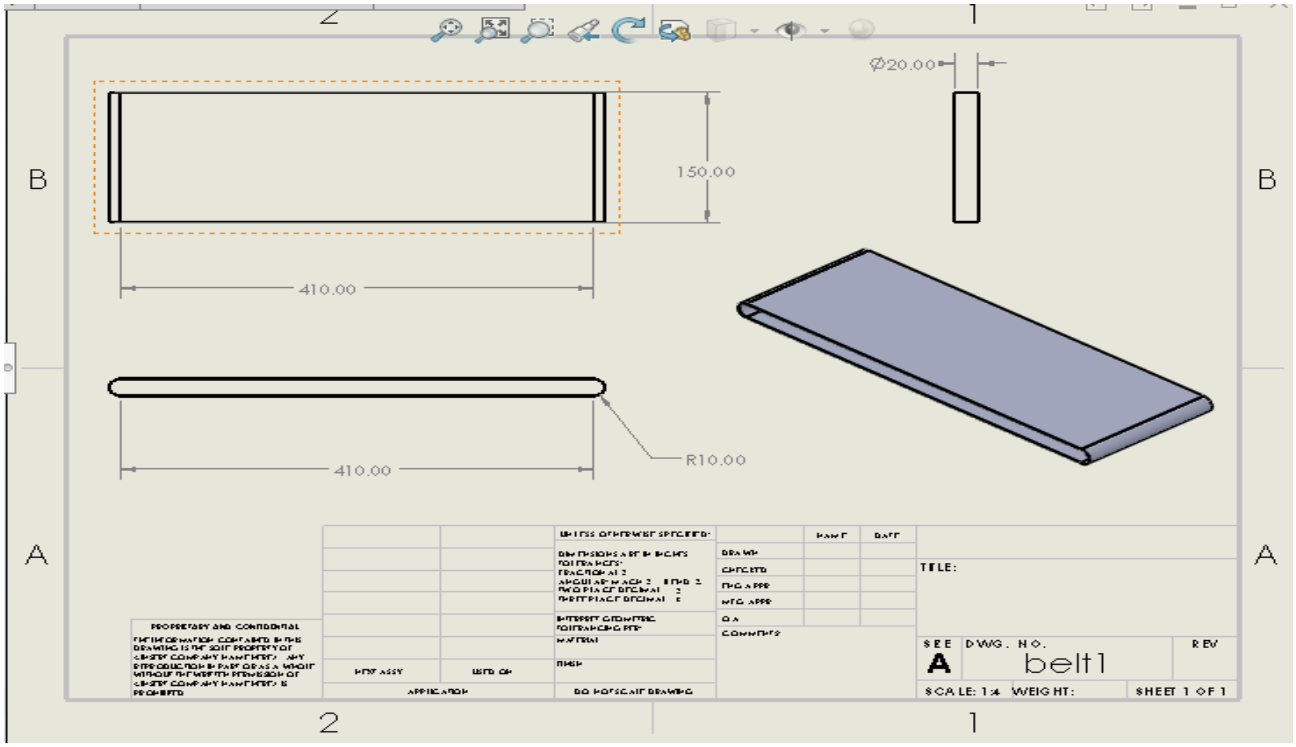


Figure 6.19 Belt

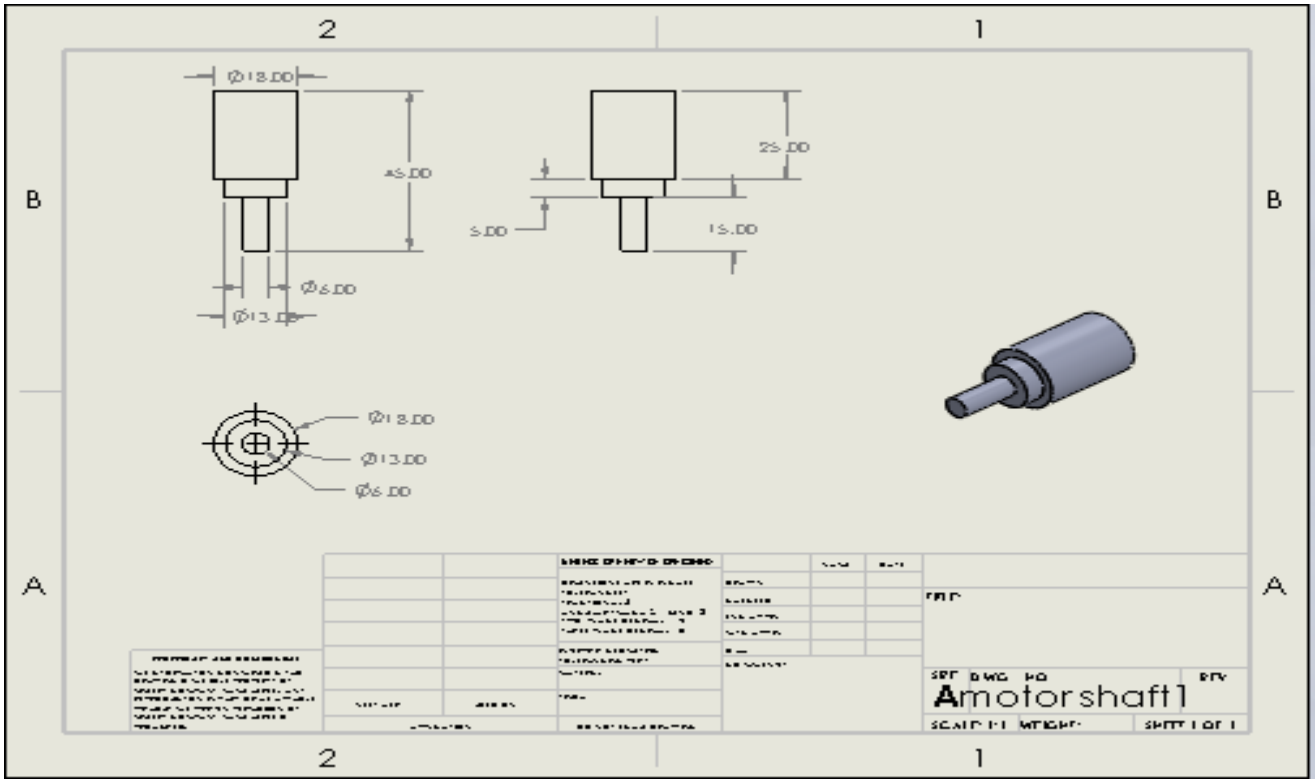


Figure 6.20 Motor

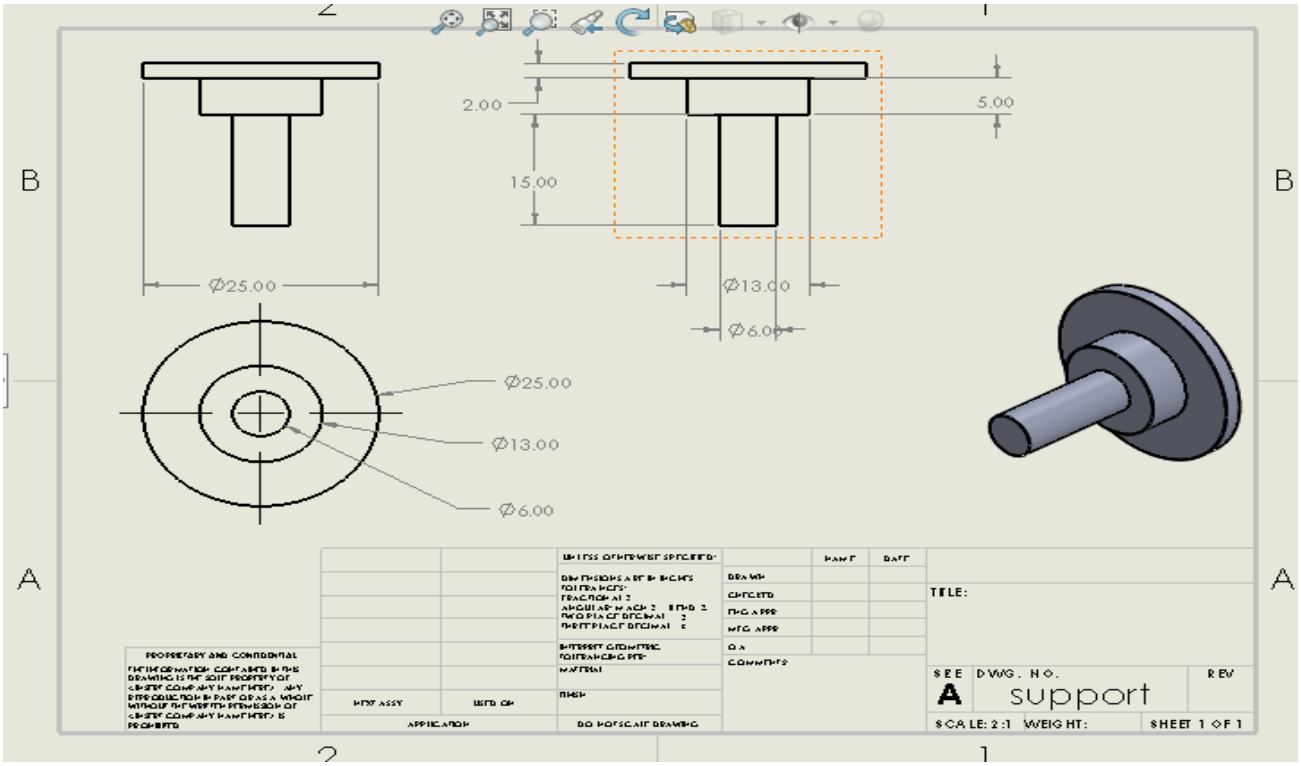


Figure 6.21 Dummy shaft

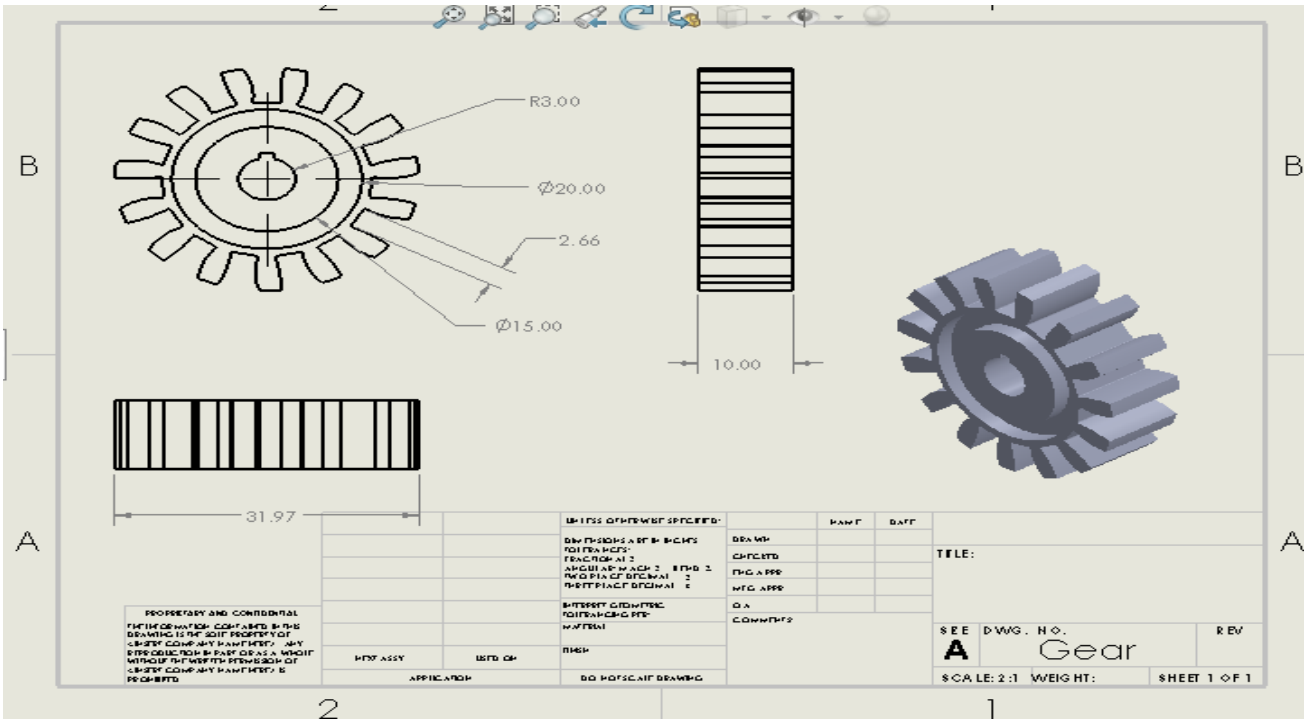


Figure 6.22 Gear

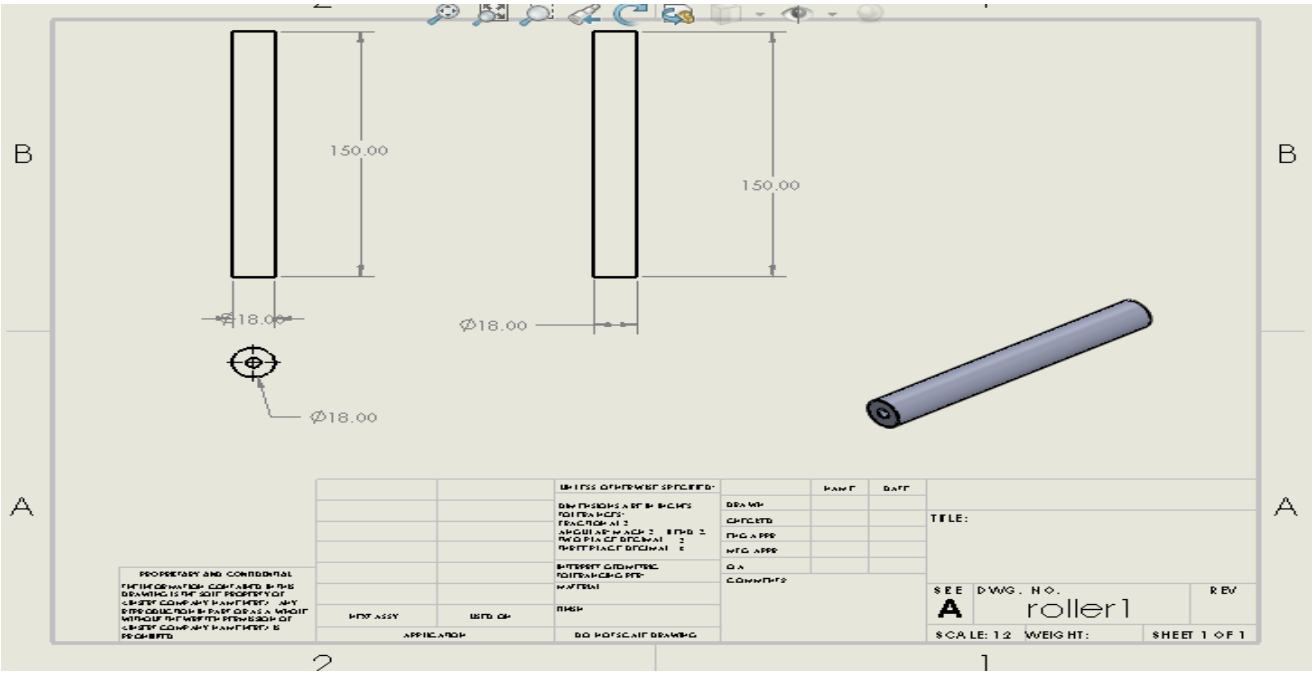


Figure 6.23 Belt conveyor roller

6.9 SOFTWARE

- **Dataset Creation**

We have downloaded the dataset from the standard Kaggle website [9] and the bifurcated the same dataset in to two folders randomly one for training the model and the other for validation of the same. We have two classes for classification one is fresh capsicum and the other is stale capsicum. Below shows the sample dataset of fresh capsicum and also the stale capsicum.

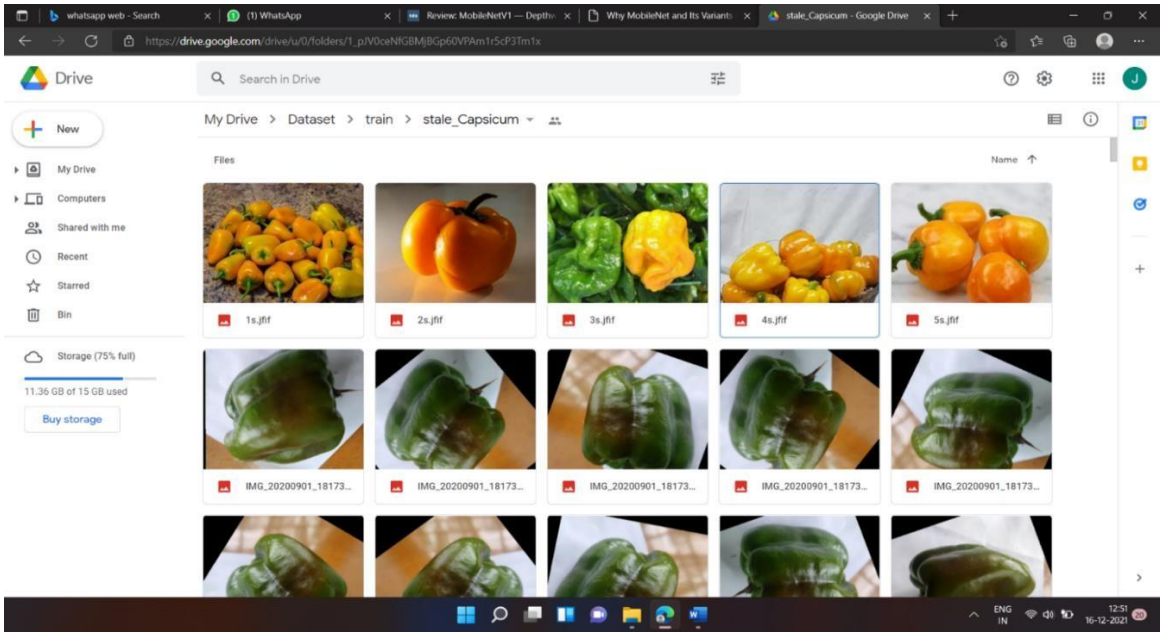


Figure 6.24 Sample Dataset of Fresh Capsicum under training dataset

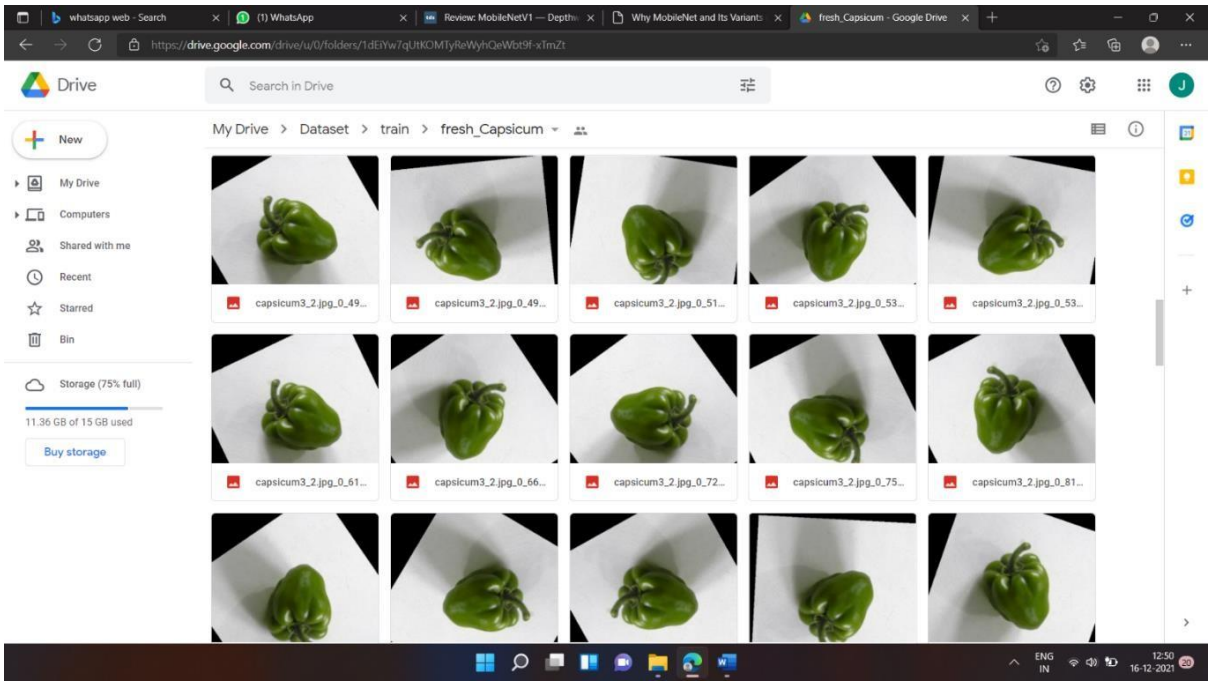


Figure 6.25 Sample Dataset of Stale Capsicum under training dataset

- **Image Processing**

Image processing basically includes the following three steps:

• The images are imported via image acquisition tool

• The images are analyzed and then manipulated

• Output in which result can be altered image or report that is based on image analysis.

- **Resizing**

Change the size of; make the size more appropriate. size - make to a size; bring to a suitable size. rescale - establish on a new scale. Resizing is done to 224x224 as mentioned above, the images were taken from smartphone, browser as well as Kaggle website so there was similar resolution of all the images as making resizing of the images an essential task to be accomplished

6.10 BILL OF MATERIALS

Table 6.5 Bill of Materials

Sl No.	Components	Cost
1	DC Motor (2)	360
2	Dumpy Shaft (4)	120
3	Adapter	150
4	L298 Motor Driver	120
5	Raspberry pi	5000
6	Foxin Webcam	1000
7	Rollers (5)	250
8	Acrylic sheet	500
9	M2 Screws and Nuts	60
10	L-Clams (8)	160
11	Struts L Slot (6) and Screws and nuts	300

CHAPTER 7

TESTING AND RESULTS

7.1 INTRODUCTION

As indicated by W.H. Thorpe, the term was formulated by C. Lloyd Morgan subsequent to evaluating comparative expressions "preliminary and disappointment" and "preliminary and practice". Under Morgan's Ordinance, creature conduct ought to be clarified in the easiest manner. Where conduct appears to infer higher mental cycles, it very well may be clarified by experimentation learning. A model is a talented manner by which his terrier Tony opened the nursery entryway, effectively misjudged as a canny demonstration by somebody seeing the last conduct. Lloyd Morgan, in any case, had watched and recorded the series of approximations by which the canine had step by step took in the reaction, and could exhibit that no knowledge was needed to clarify it [10].

Now, after designing and developing the product. The testing phase is next. Where each and every product before marketing it or production of it being done it has to be tested several times and also verification of the results should be performed. Testing of a product can be done in various ways and there are several methods for testing the product.

Similar is the case of our product. After fabricating the hardware part and also the software coding and debugging being done several times. After all the process we have then done final testing by integrating both hardware and software. Testing is for both the phases after getting integrated.

Facing many issues during the integration of both the sub-systems, we finally come into a conclusion of the system working properly. We have used trial and error method in testing phase.

7.2 TESTING METHODS

Using, Trial and error method we have completed the testing phase on our product. We have placed a capsicum on roller (name it as roller 1) and the motors were powered on, and

likewise the rollers started turning and carrying the capsicum from one start of the roller to the other part where there is a conveyor placed and this conveyor at the end has two basket which sorts the capsicum into fresh or stale ones. Firstly, the capsicum was not revolving so we couldn't capture the all phases of the capsicum, so we used paint roller brushes for providing high friction to the capsicum so it could revolve as well as rotate. Now, we could capture all images from all the sides of the capsicum. Capsicum from the roller belt was not getting transferred to the conveyor system, so we changed the design of the roller and made it a little height from one side.

And thus, successfully we completed the testing phase by trial-and-error method and the end result were achieved as per the need statement.

7.3 RESULTS (SNAPSHOTS)

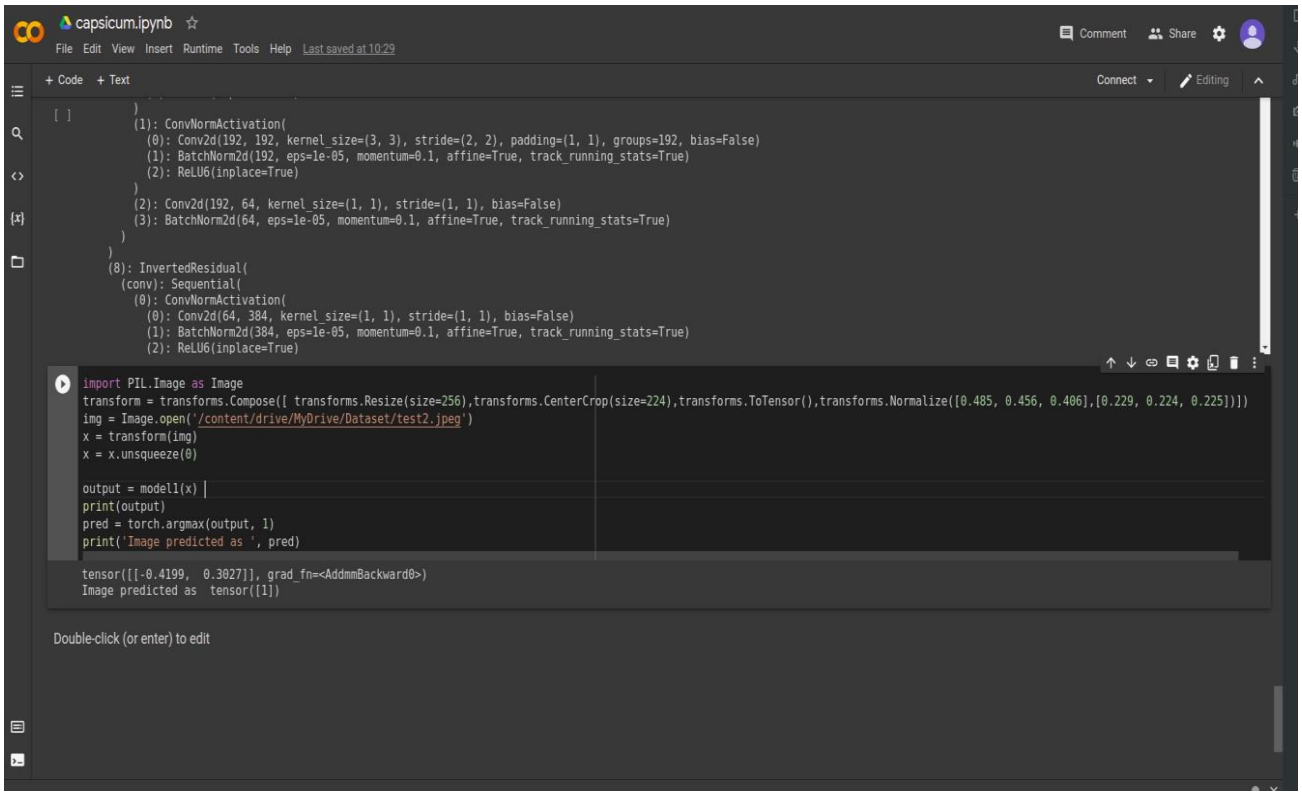


Figure 7.1 Output from the pre-trained model

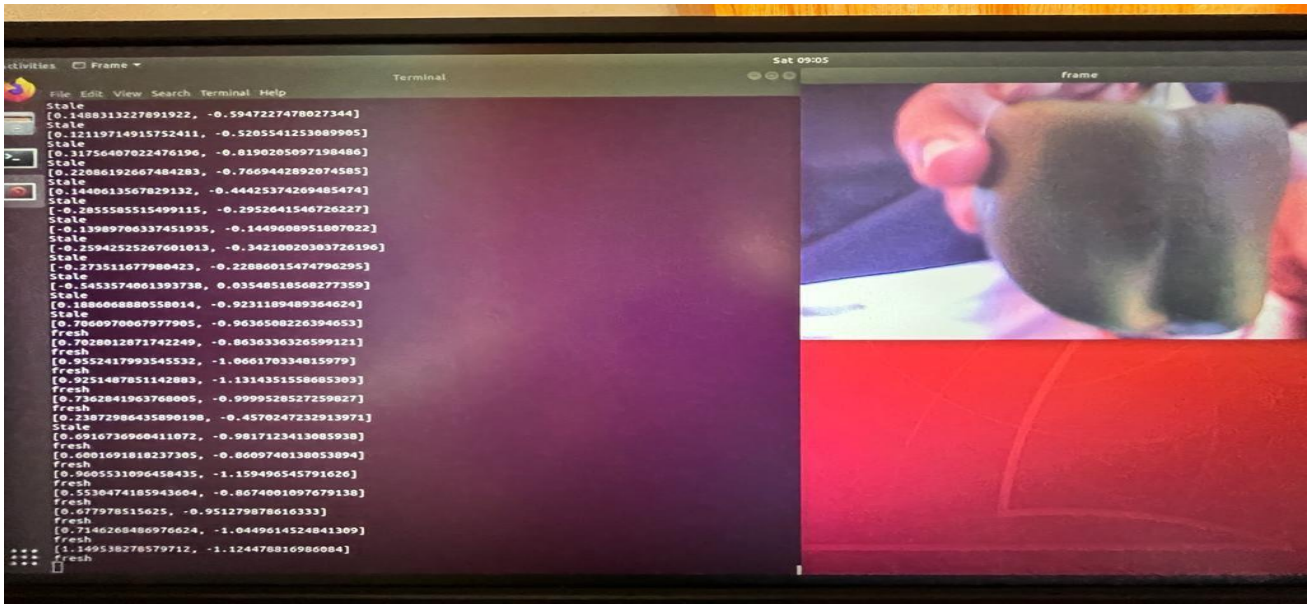


Figure 7.2 Output from the testing showing fresh capsicum

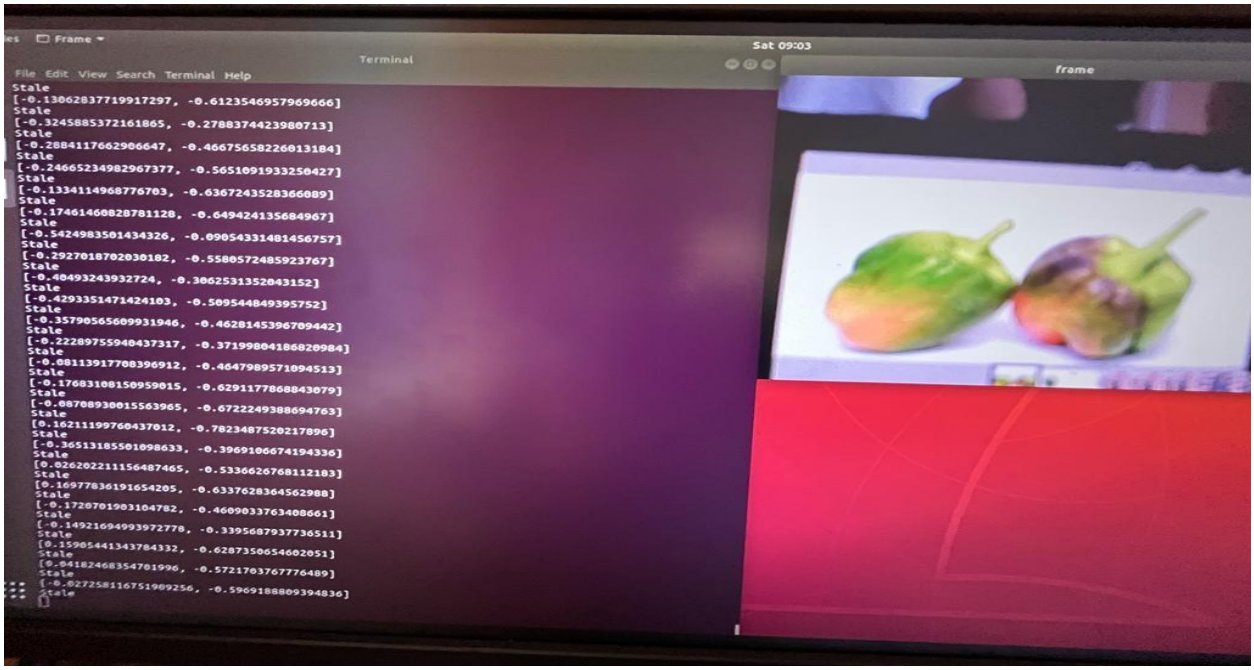


Figure 7.3 Output from the testing showing stale capsicum.

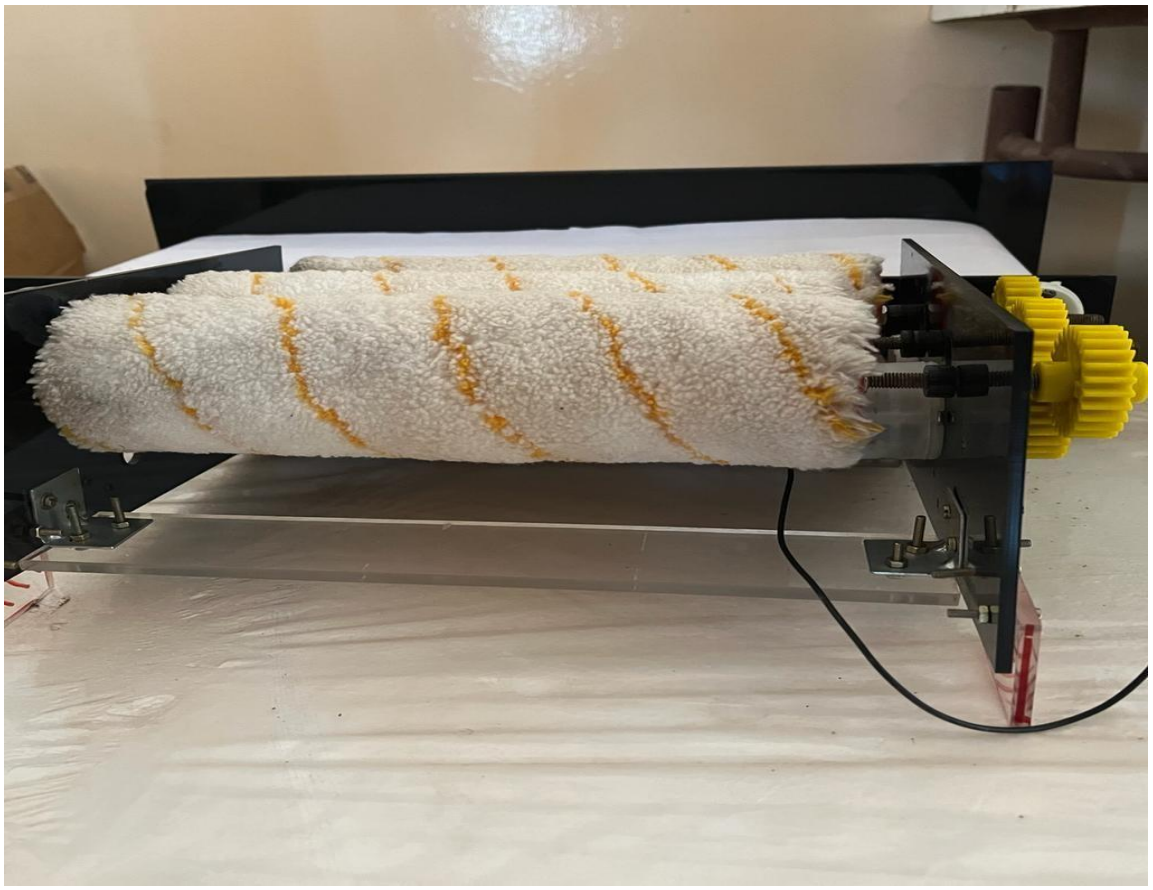


Figure 7.4 Prototype sideview

Figure 7.5 Top view of prototype.

CHAPTER 8

CONCLUSION

In this project, we focused on grading and sorting capsicum. grading and sorting of capsicum using the concepts of robotics, automation concepts of machine learning, and deep learning. We have successfully implemented CNN mobile net algorithm with a robotic operating system (ROS) for grading and sorting of capsicum and achieved the accuracy of 80% detection.

CHAPTER 9

FUTURE SCOPE

This project is meant for the food industry, where grading and sorting needs to be done. This project can be integrated to the food industries and it uses the image processing technique through which the fruits can be graded and sorted accordingly.

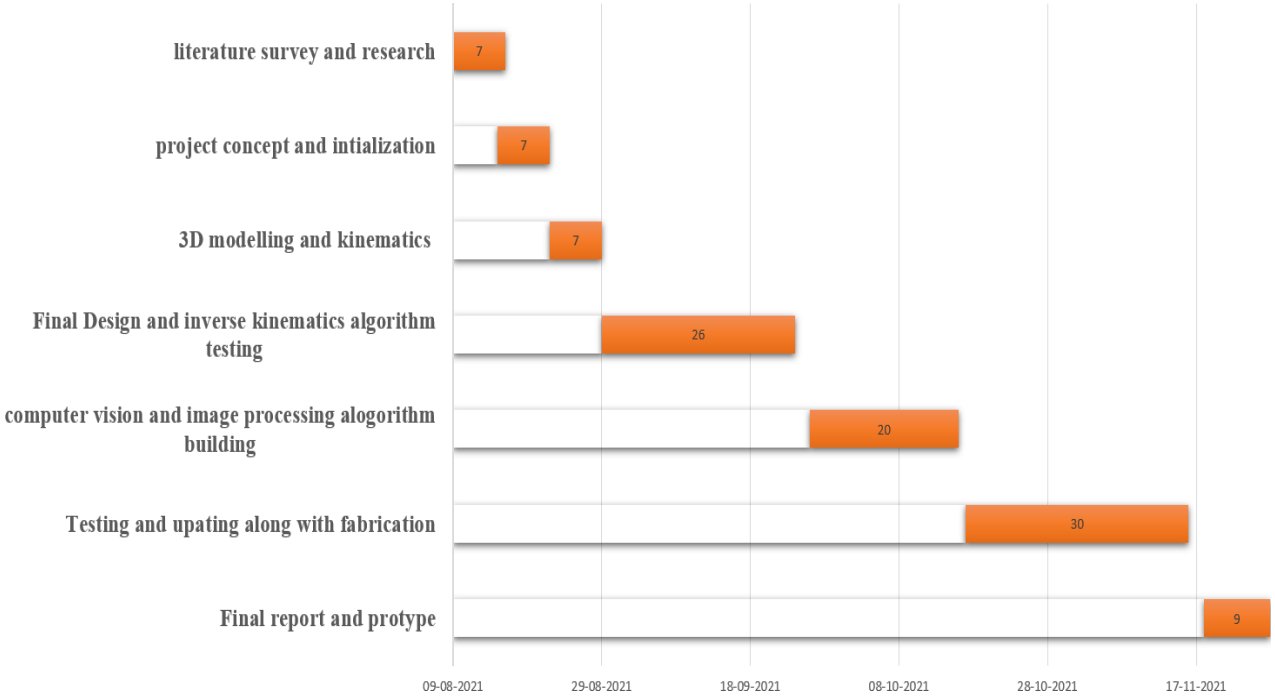
As current in industries it is done manually, which demands labor cost and this prototype will automate the process of grading and sorting. This process is less time consuming which can help the industry to produce their by-products in large quantity in less time. This project can help the industry to grade and sort the fruit and vegetables easily with some datasets and gives the accuracy of 80%.

The project is for agricultural and industrial benefits. This project is just on a single vegetable that is capsicum. But nowadays, many farmers practice multi cultivating of the crops. So, we can further add the features of different vegetables or the fruits in the scope of advancing the product and making it an eligible for industries cultivating many food products(vegetables/fruits).

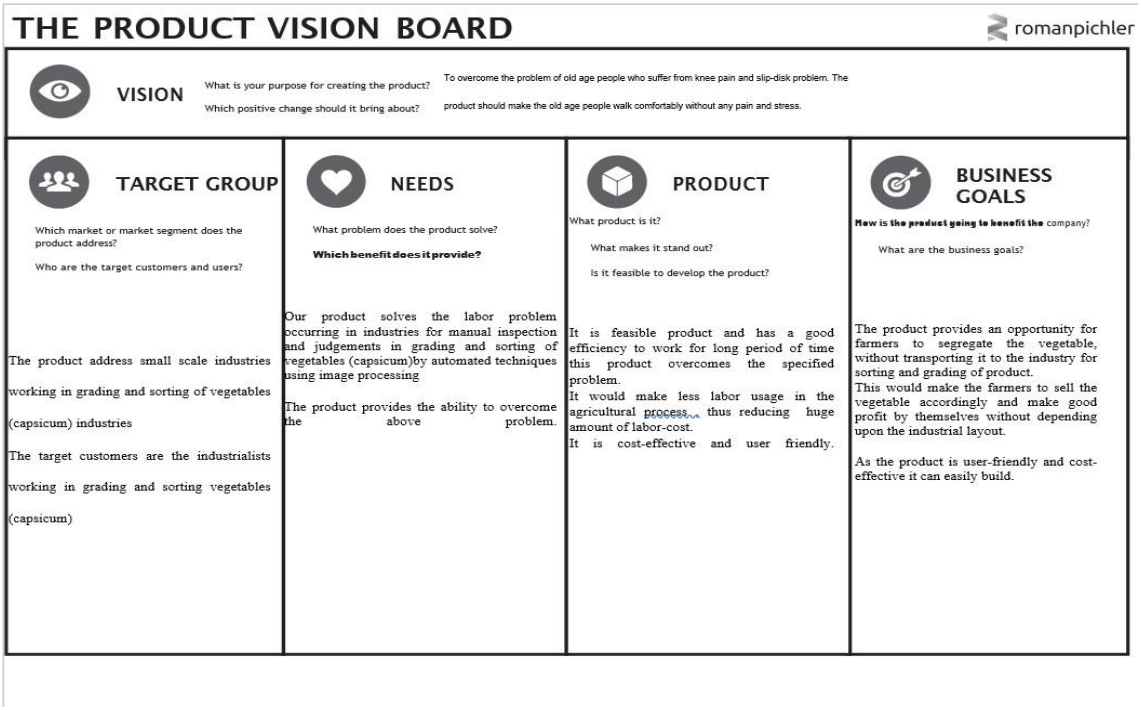
And also, the product is based on color, many other features like size can be added upon which gives the product an enhanced view in the market and also an option to outstand with other existing similar projects.

APPENDIX

Gantt Chart:



Product 'Vision Board:



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