PROJECT REPORT ON

GANTRY LOADER TURNING MACHINE

L&T Technology Services, Vadodara

Submitted in partial fulfillment of the requirements for the award of the degree

Bachelor of Engineering

In

Mechanical Engineering

Submitted by

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01FE18BME183

2021-22

School of Mechanical Engineering

CERTIFICATE

Certified that the Project work carried out by Mr. Anirudh B Gudi., SRN: 01FE18BME183, a bonafide student of **K L E Technological University, Hubballi**, in partial fulfillment for the award of Bachelor of Engineering /Bachelor of Technology in Mechanical Engineering of the during the year 2018-2022. It is certified that all corrections/suggestions indicated for Internal Assessment have been incorporated in the Project report deposited in the school library. The Project report has been approved as it satisfies the academic requirements in the said Degree.

Name:	Name:	Name:
Signature:	Signature:	Signature:
(University Guide)	(Head, SME)	(Registrar)

External Viva
Name of the examiners Signature with date
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Abstract

The Project presents the design and implementation of a Pick and place Cartesian machine, which performs pick and place mechanism and also detect the obstacles coming in its path. Picking and placing manually is the inefficient flaws for the production line industries. It became less productive, slow and nonflexible processing when it comes to manual mechanism. To overcome this problem we introduce a 3 axis rectangular Cartesian machine. This is a Cartesian coordinate robot, which performs pick and place mechanism and also detects the obstacles which encounters in its path. The system comprises of gantry robot with a rack and pinion system, and completely controlled by programmable logical controller. This provides the effective design of the system. The most important requirement to consider were those regarding accuracy, weight of the object, only metal and detection, obstacle detection and overall cost of the system.

Acknowledgement

While carrying this project, I came across a number of people whose contributions in various ways helped me to obtain the better knowledge and they deserve special thanks. It is a pleasure to convey my gratitude to all of them.

I would like to express my sincere gratitude to my industrial guide Mr. Tanmoy Mukherjee, senior GEA faculty L&T Technology services, for his invaluable encouragement, suggestions and support and providing me extraordinary experiences throughout the work. His involvement with originality has triggered and nourished my intellectual maturity that will help me for a long time to come.

I would like to express my deep sense of gratitude and indebtedness to my internal guide Prof. Vinayak Khatwate , KLE Technological University, Hubballi for his immense help in guiding me to enhance my knowledge & skills. I am proud to record that I had the opportunity to work with an exceptionally experienced Professor like him.

I would also like to thank Prof. B. B. Kotturshettar, HOD school of mechanical engineering, KLE Technological University, for giving me a chance to experience the industry training and Project as part of my degree. I am also thankful to all faculty members of the School Mechanical Engineering Department of KLE Technological University, for helping us directly or indirectly in different stages of the training and providing us this great opportunity.

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Capstone Project:

Need Statement:

It is required to design a gantry loader system for CNC turning machine/lathe for picking the work piece from a specified location and place it in position for the chuck or collect to grip it. The weight carrying capacity of the loader should be minimum 3 kg. A vertical lift of 1500 mm, horizontal travel of 1000 mm is essential in the working envelope. The pick-up position is in vertical orientation and the chuck/collect is horizontal orientation. The loader is required to be equipped with provision to orient the work piece appropriately.

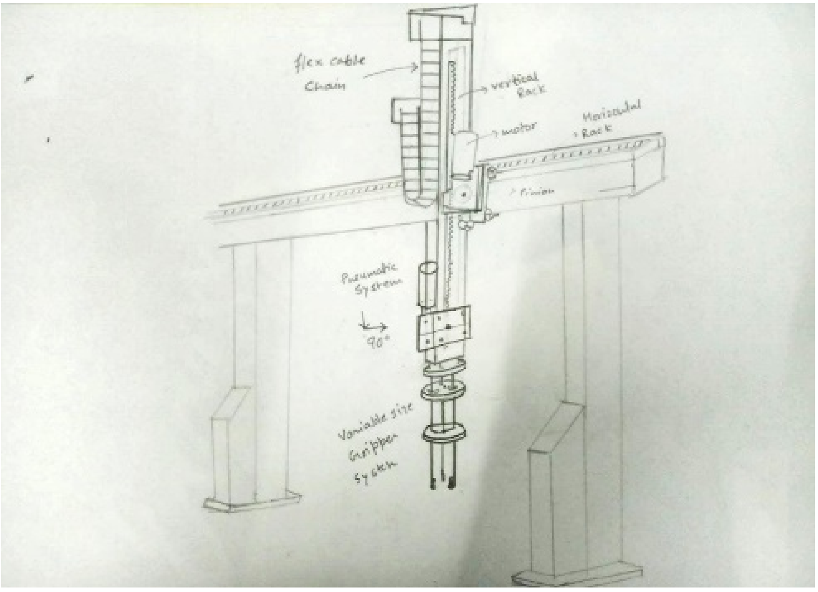
Overview:

GLTM required designing the mechanism for picking the workpiece from the pick-up location and transferring it to the chuck/collect. The design should clearly provide the mechanism implemented, design calculations for strength/dimensions for each link/component and justify selection of any off-the-shelf component like bolts, bearings, bushes, motors, couplings etc. You can select the gripper/end effecter of your choice but you need to clearly specify its features and limitations.

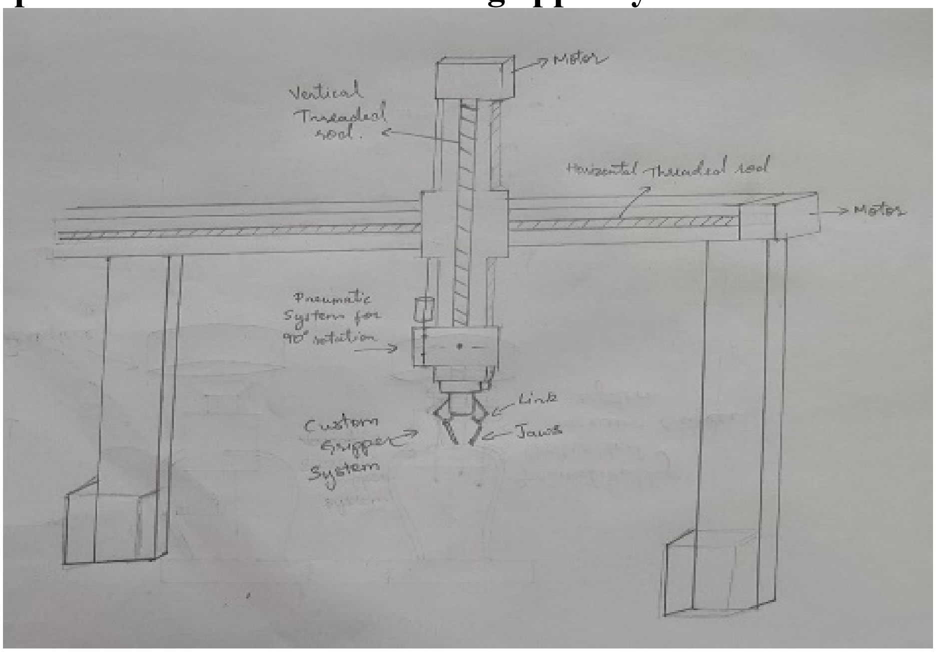
Concept Generation:

We have generated two concepts for the given need statements and opted for the best and most feasible solution using the parameters of Product Development and Lifecycle

Concept 1: Rack and Pinion with variable size gripper; (Chosen concept)

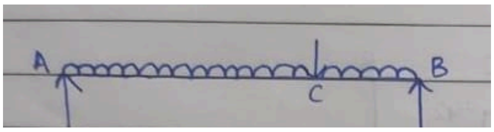


Concept 2: Lead Screw with customgripper system:

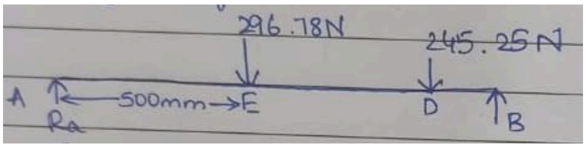


Design Calculation:

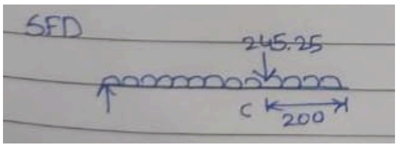
- Bending Moment of Horizontal Beam:



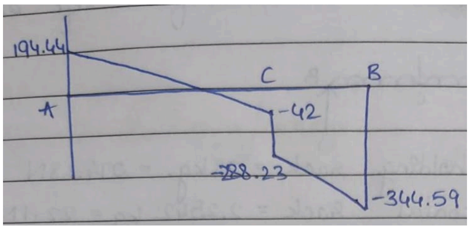
When vertical system is at 800 mm from left and,
weight of bar holding rack= 28 x 9,81 =274.68 N
weight of horizontal rack = 2.2542 x 9.81 = 22.1 N
total weight of vertical system= 25 x 9.81 = 245.25 N
total weight of horizontal beam= 296.78 N



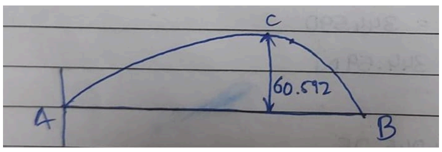
Rb=344.44 N
Ra + Rb = 296.78+245.23
Ra=194.44 N



SF at A: +194.44 N
SF at C: +194.44 – (296.77 x 800/1000) = -42.984
SF at B_2: -288.234-95.59
: -344.59 N
SF at B_1: -344.59 + 344.59 N =0



BM at A: 0
BM at C: 60.692 N/m
BM at B: 0



- Vertical Rack & Pinion:
  M=11 kg
  V=1.08 m/s
  G=9.81m/s
  Db=60.48
  α=V/tb = 1.08/0.27 =4 m/s^2
  Now, we have selected Pinion **D1.5238** and Rack **1.58R150CIO** from Apex Dynamics which has maximum feed force (F2b) of 1.984 KN and a maximum torque (T2b) of 60N-m
  For vertical operation , tangential force of rack is :
  Fn=Mg+Mα
  =151.91N
  Fnv=Fn x Sb
  =303.82 N
  Torque is Tn=Fn x d/2000 = 4.59N/m
  Demanded Torque Tnn= 4.59x2=9.18N-m
  Hence , since F2b>Fn , T2b> Tn ,
  Our selection is valid.

  Weight of Rack :3.3813 kg
  Weight of Pinion:0.381 kg

- Weight of Vertical system:
  Material : Alluminium 1100
  Density: 2.7g/cm^3
  Dimensions of Bar : 175 x 10 x10 cm (1 gauge=7.6mm thickness)
  Volume : (175 x 10 x10)-(175 x 9.24 x9.24)
  :2558.92 cm^3
  Weight :ρ x v : 2.7 x 2558.92 = 6.909 kg
  Total Weight of Vertical System : 6.909 +3.3183+0.381+11
  : 22.103 kg

- ## Horizontal Rack & Pinion:

M=44.83 kg
V=1.08 m/s
G=9.81m/s
Db=60.48
α=V/tb = 1.08/0.27 =4 m/s^2
Now, we have selected Pinion **D1.5L38** and Rack **1.58R150CIO** from Apex Dynamics which has maximum feed force (F2b) of 1.984 KN and a maximum torque (T2b) of 60N-m
For vertical operation , tangential force of rack is :

Fn=Mg+Mα
=619.1091 N
Fnv=Fn x Sb
=1238.2046 N

Torque is Tn=Fn x d/2000 = 18.833N/m
Demanded Torque Tnn= 18.833x2=37.66N-m
Hence , since F2b>Fn , T2b> Tn ,
Our selection is valid.

Weight of Rack :2.542 kg
Weight of Pinion:0.381 kg

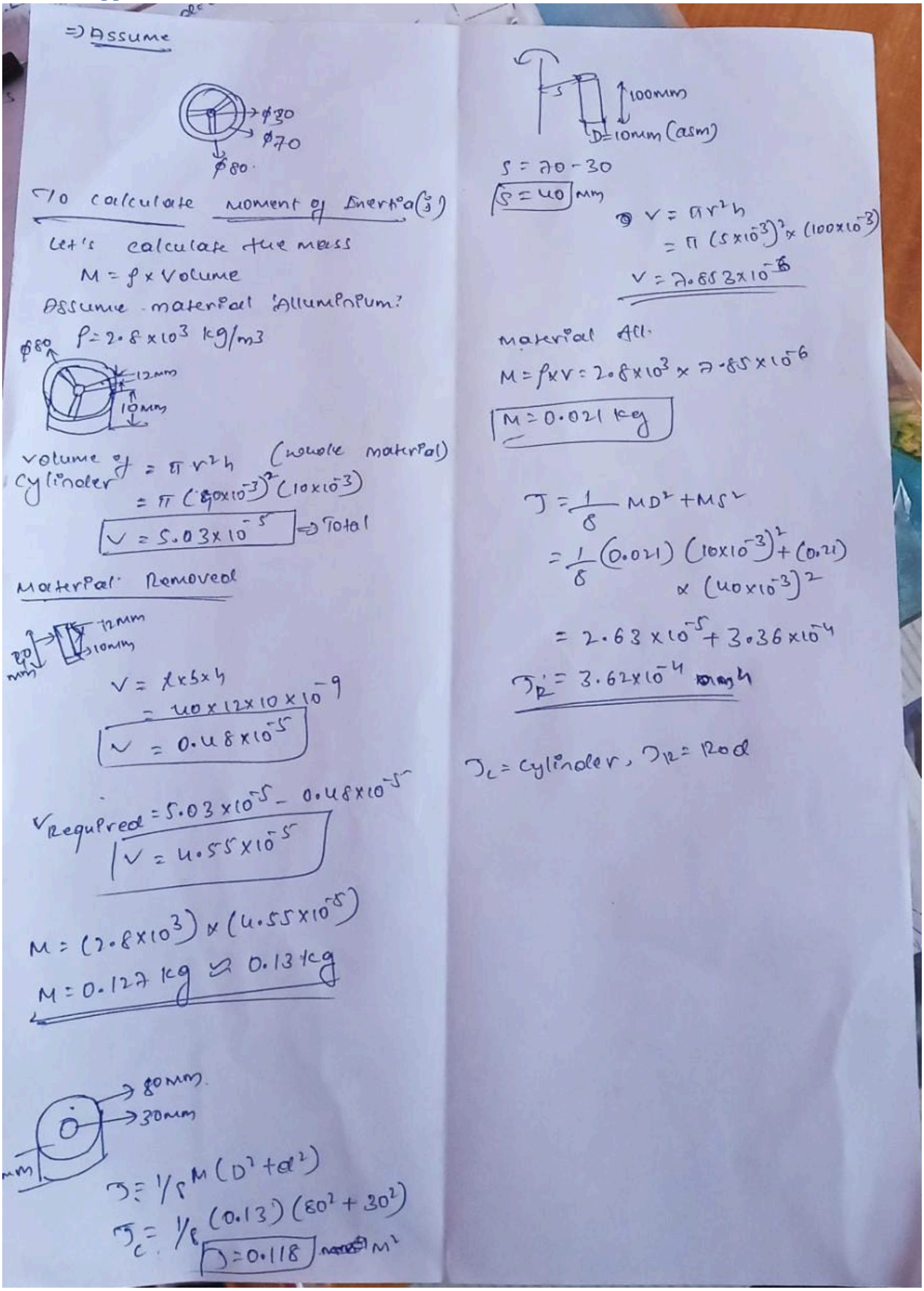
- ## Weight of Horizontal system:

Material : Alluminium 1100
Density: 2.7g/cm^3
Dimensions of Bar : 150 x 10 x10 cm (1 gauge=7.6mm thickness)
Volume : (150 x 10 x10)- (150 x 9.24 x9.24)
:2193.36 cm^3
Weight :ρ x v : 2.7 x 2193.36= 5.922 kg
Total Weight of Vertical System : 5.922 +2.542+0.381
: 8.845 kg

- ## Total Weight of the system:

Weight of Horizontal system+ Weight of Vertical system : 8.845+22.103 =30.948kg ~ 31kg

- Gripper Calculation:



⇒ Assume

ϕ30
ϕ70
ϕ80

To calculate moment of Inertia (J)

Let's calculate the mass

$M = \rho \times$ Volume

Assume material 'Alluminium'

$\rho = 2.8 \times 10^{3}$ kg/m3

ϕ80
12mm
10mm

volume of cylinder $= \pi r^2 h$ (whole material)

$= \pi (40 \times 10^{-3})^2 (10 \times 10^{-3})$

$\boxed{V = 5.03 \times 10^{-5}}$ → Total

Material Removed

12mm
10mm
20 mm

$V = l \times b \times h$

$= 40 \times 12 \times 10 \times 10^{-9}$

$\boxed{V = 0.48 \times 10^{-5}}$

$V_{Required} = 5.03 \times 10^{-5} - 0.48 \times 10^{-5}$

$\boxed{V = 4.55 \times 10^{-5}}$

$M = (2.8 \times 10^{3}) \times (4.55 \times 10^{-5})$

$M = 0.127$ kg ≈ 0.13 kg

80mm
30mm
mm

$J = 1/8\, M (D^2 + d^2)$

$J_c = 1/8 (0.13)(80^2 + 30^2)$

$\boxed{J = 0.118}$ m²

S
100mm
D = 10mm (asm)

$S = 70 - 30$

$\boxed{S = 40}$ mm

$V = \pi r^2 h$

$= \pi (5 \times 10^{-3})^2 \times (100 \times 10^{-3})$

$V = 7.853 \times 10^{-6}$

Material All.

$M = \rho \times V = 2.8 \times 10^{3} \times 7.85 \times 10^{-6}$

$\boxed{M = 0.021 \text{ kg}}$

$J = \frac{1}{8} MD^2 + MS^2$

$= \frac{1}{8}(0.021)(10 \times 10^{-3})^2 + (0.021) \times (40 \times 10^{-3})^2$

$= 2.63 \times 10^{-5} + 3.36 \times 10^{-4}$

$J_R = 3.62 \times 10^{-4}$ m⁴

J_c = Cylinder, J_R = Rod

- Pneumatic Actuator Calculation:

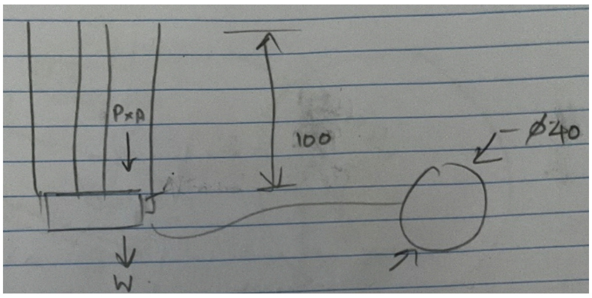
From the calculations below we can take the MINDMAN MCQ12-11-40-100 M Pneumatic actuator.

P x A: W

P : (98 x 4 / 3.14 x 40x40)

P : 0.34907 N/mm^2

3.4907 Barr=0.3904 Mpa



Model	MCQI2
Tube I.D. (mm)	32,40,50,63,80,100
Medium	Air
Operating perssure range	0.05~1 MPa
Proof pressure	1.5 MPa
Ambient temperature	-5~+60°C (No freezing)
Available speed range	50~500 mm/sec
Sensor switch (*)	RCI

Components used:

- Total weight lifting capacity: 30kg
- Maximum Bending moment on Horizontal Beam: 60.592N/m
- Maximum Bending moment on Piston Rod of Pneumatic Cylinder in gripper: 1.56N/m
- Rack Used: Apex Dynamics 1.58R ISO CIO
- Pinion Used: Apex Dynamics D1.5L 38
- Servo Motor used in Gripper: Mitsubishi HG KN 23
- Servo Motor used in gantry system: Mitsubishi HG-SN202J
- Motor Driver Used: Mitsubishi MR-JE-200A
- Pneumatic Actuator used: MINDMAN MCQ12-11-40-100 M

(All the components fit the system requirements and design calculation are available.)

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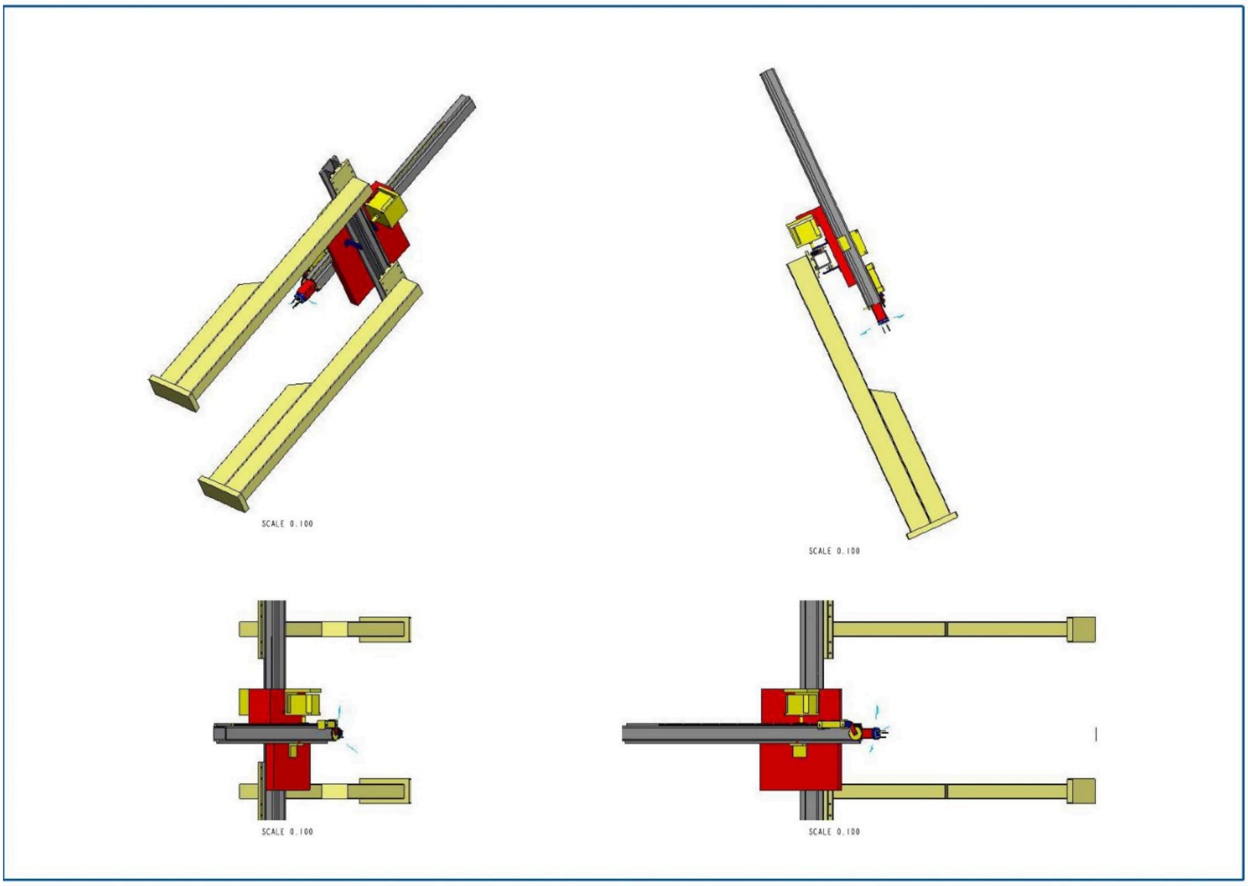
CAD Model:

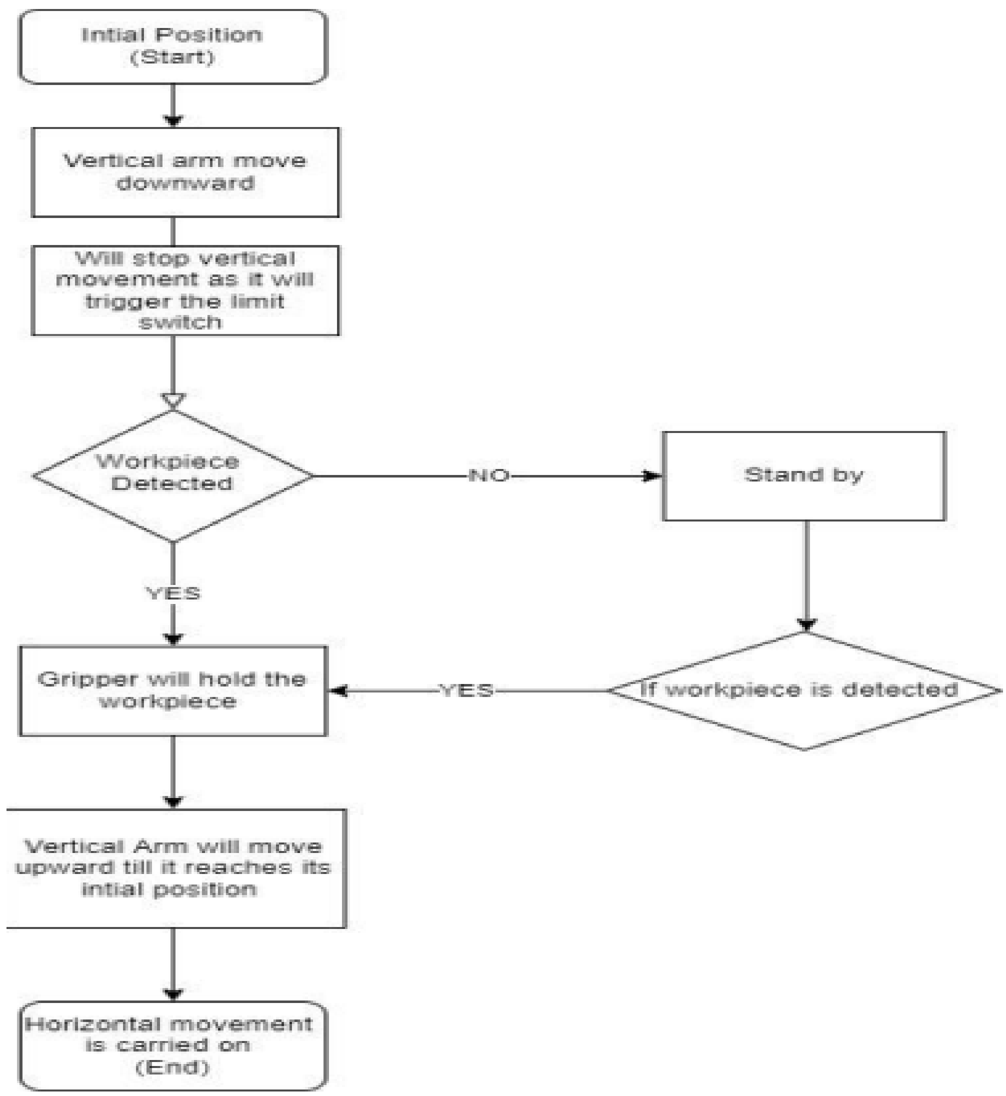


System Design Project:

Subsystems:
Our solution has been divided in to 5 subsystems:

- Vertical Gantry
- Horizontal Gantry
- Gripper
  - Detection of work piece
  - Detection of chuck axis
- Pneumatic System
- Controller

Vertical Gantry:



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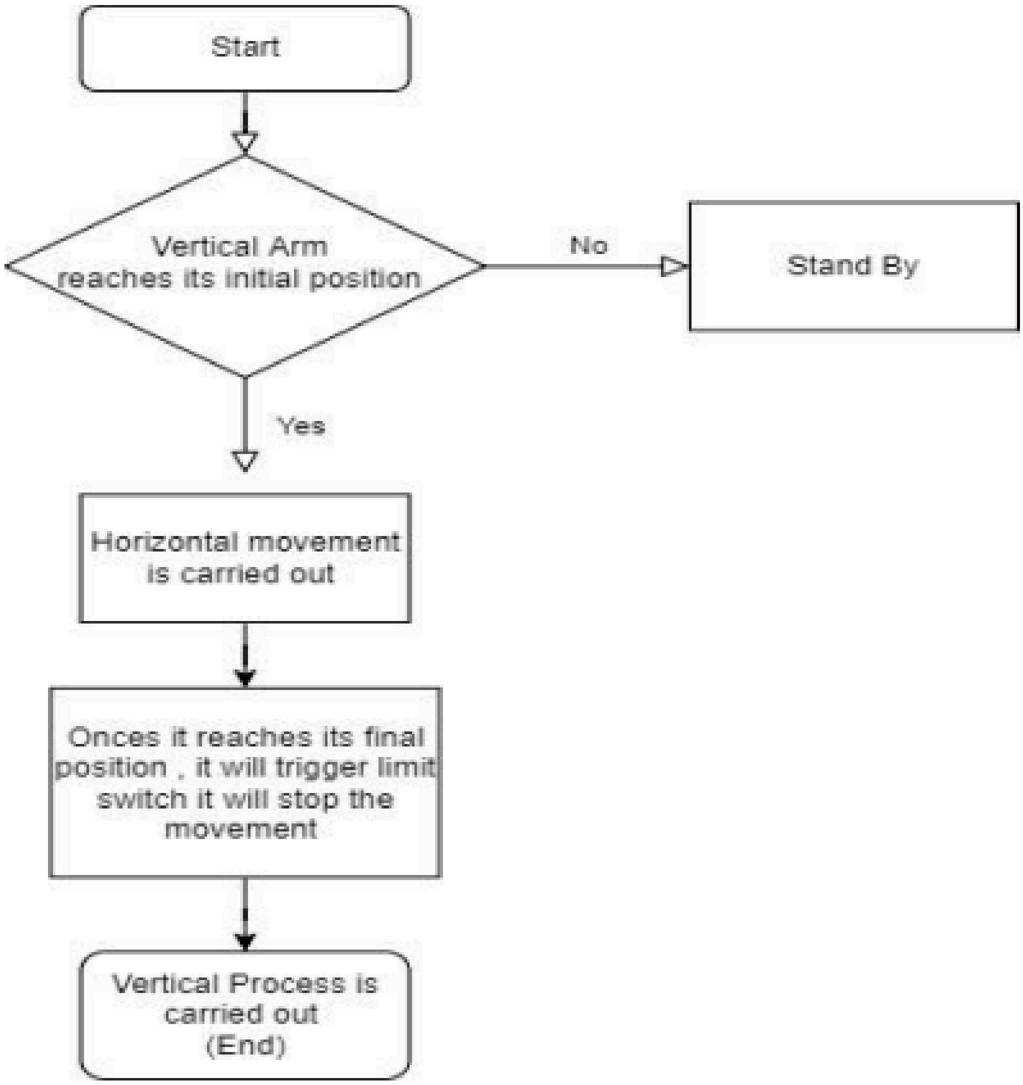
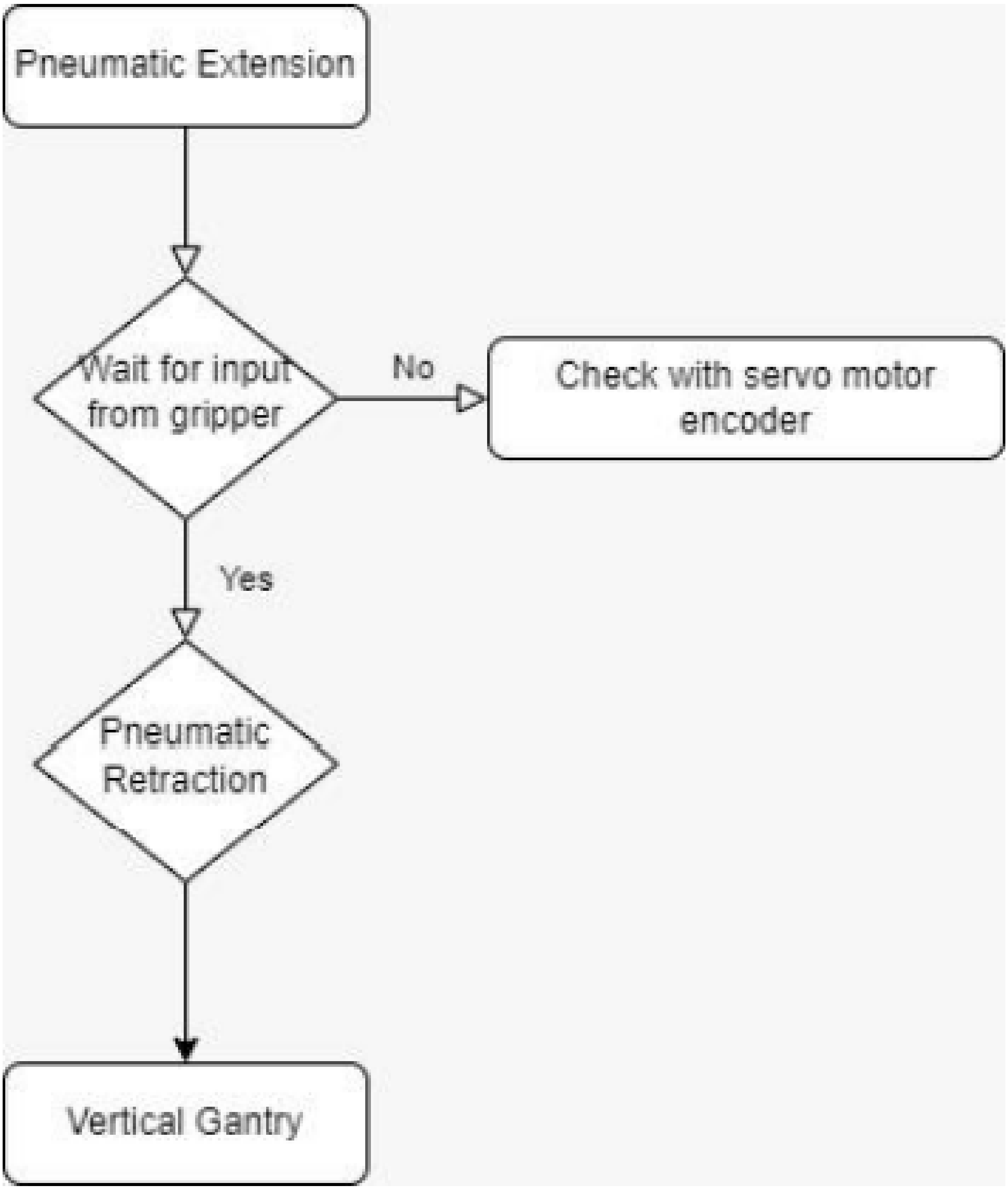
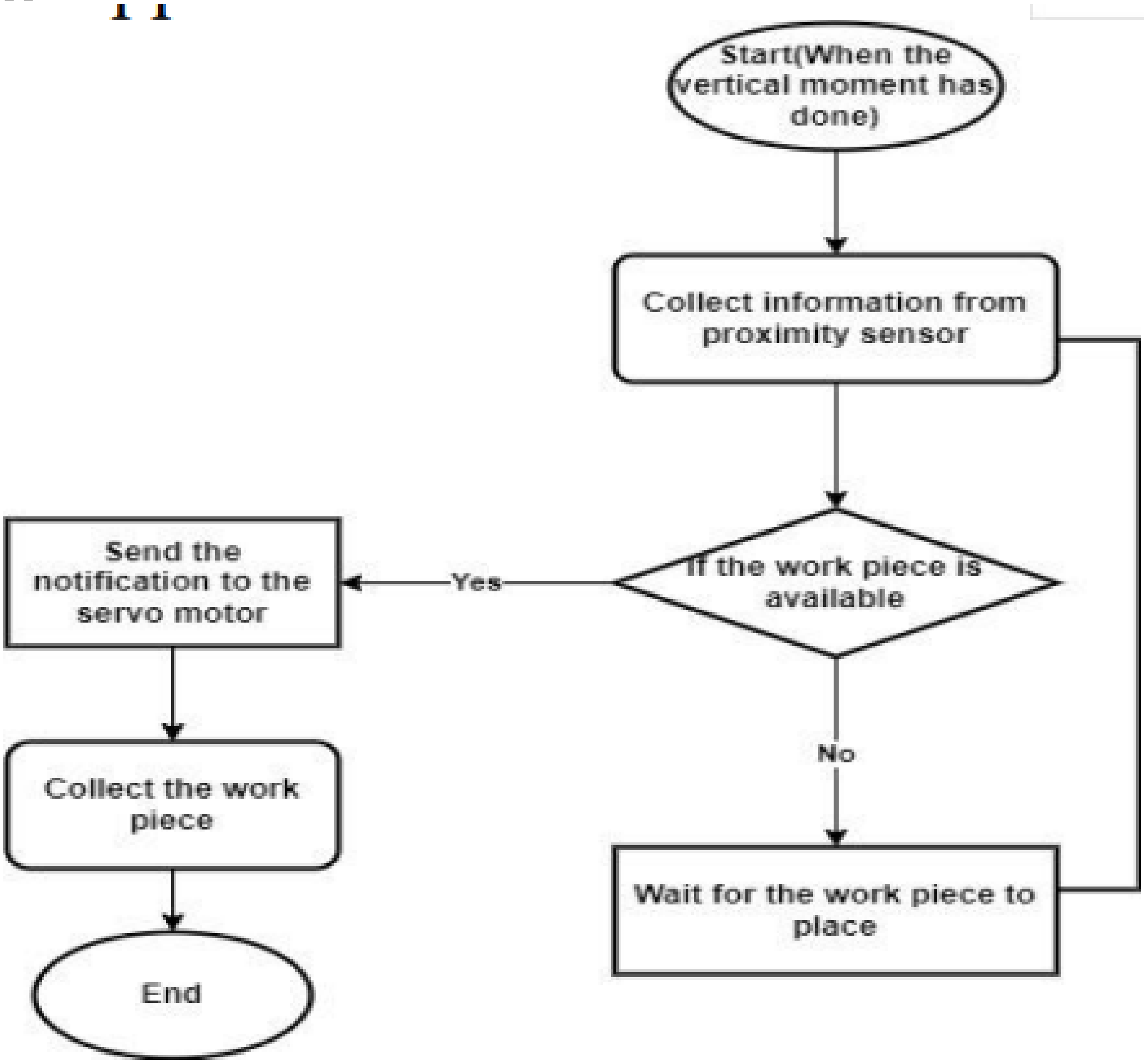
Horizontal Gantry:



Pneumatic arm Rotation:



Gripper Actuation:



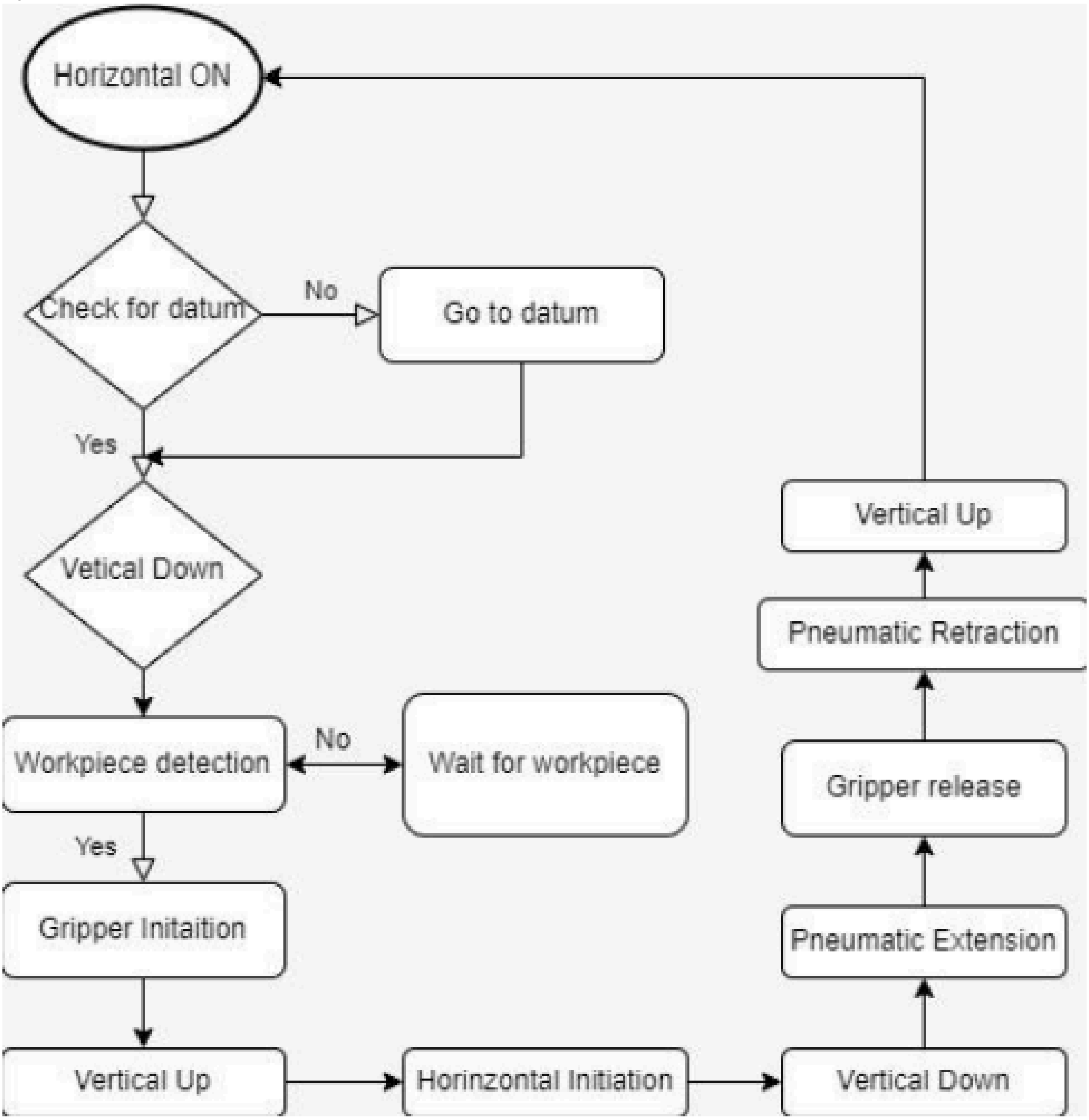
Controller:

After studying the application, we have decided to use a Programmable Logic Controller for the GLTM System, The detailed study of I/O's for PLC is given below,

Sr No.	I/O Details
1	Vertical Gantry Servo
2	Horizontal Gantry Servo
3	Proximity Sensor
4	Limit Switch (Vertical)
5	Limit Switch (Horizontal)
6	Gripper Servo
7	Pneumatic Pump

From the above table we can justify the selection of FX5U-32MT-ESS PLC

System Flowchart:



Minor Project: (Individual)

In this offline project during the Training period at Vadodara I have worked on Creo Parametric by PTC and Solid Works by Dassault Systems

Creo Parametric by PTC:

Here I have worked on

- Part Modeling using 'Sketch and Model Add ons
- Surfacing
- Sheet Metal
- Family Table
- Flexible Modeling
- Assembly
  - Static Assembly
  - Dynamic Assembly
    - Mechanisms
    - Animation Study
  - Exploded View
- Representations
- User Defined Features
- Core-Cavity
- Drafting
  - Broken View
  - Dynamic Section View
  - Bill of Materials
  - Exploded View with lines

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CATIA by Dassault Systems:

Here I have worked on

- Part Modeling using ‘Sketch and Model Add ons
- Surfacing
- Sheet Metal
- Configurations
- Assembly
  - Advance Mates
  - Mechanisms
  - Motion Study
  - Exploded View
- Core-Cavity
- Drafting
  - Broken View
  - Dynamic Section View
  - Bill of Materials
  - Exploded View with lines

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Conclusion:

We designed the Gantry Loader Turning Machine (GLTM) for Holding and placing the Raw material of 3kg weight, which is having a moment of 1000mm Vertical and 1500mm Horizontal. From above calculations, the Gripper has holding the raw material up to 30mm-70mm diameter. From these calculations we designed GLTM in CREO and integrated the mechanical system with electronic components via the system design project.
And also the the Miniprojects in respective software concluded that we can achieve desired motion along with simulation of any complex design that leads to proper use of resources and workforce.

References:

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