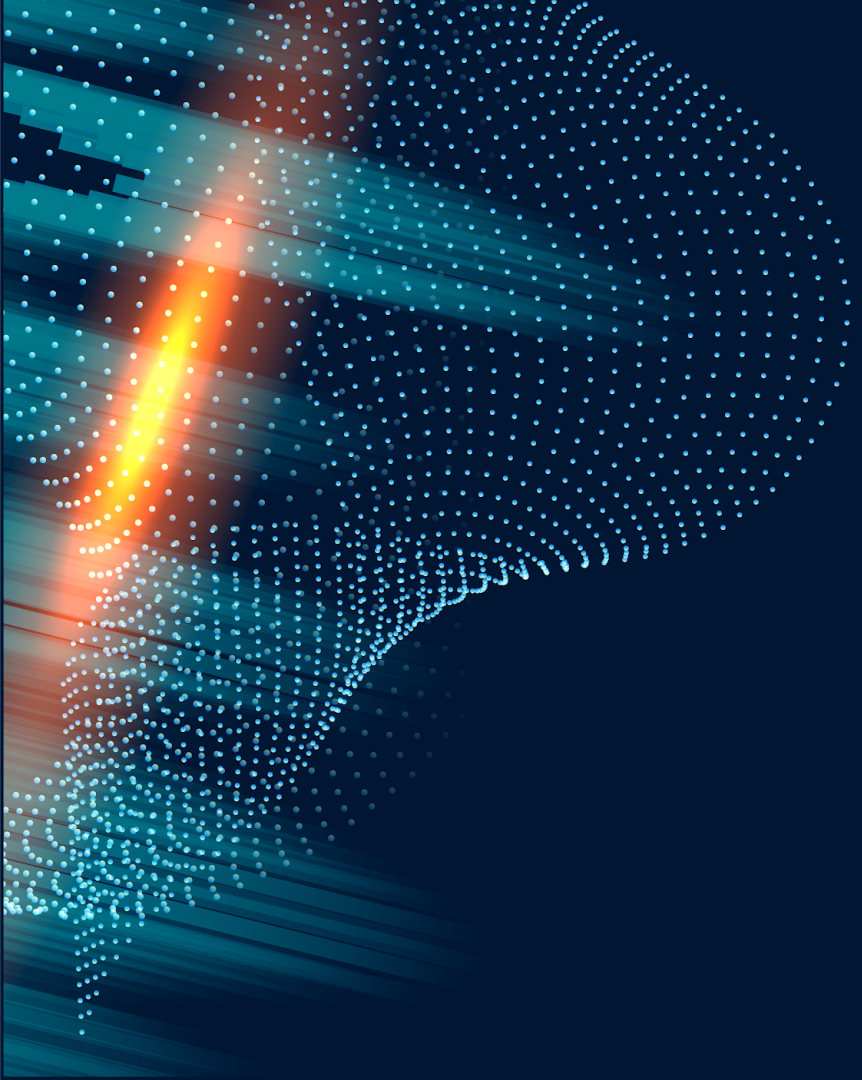
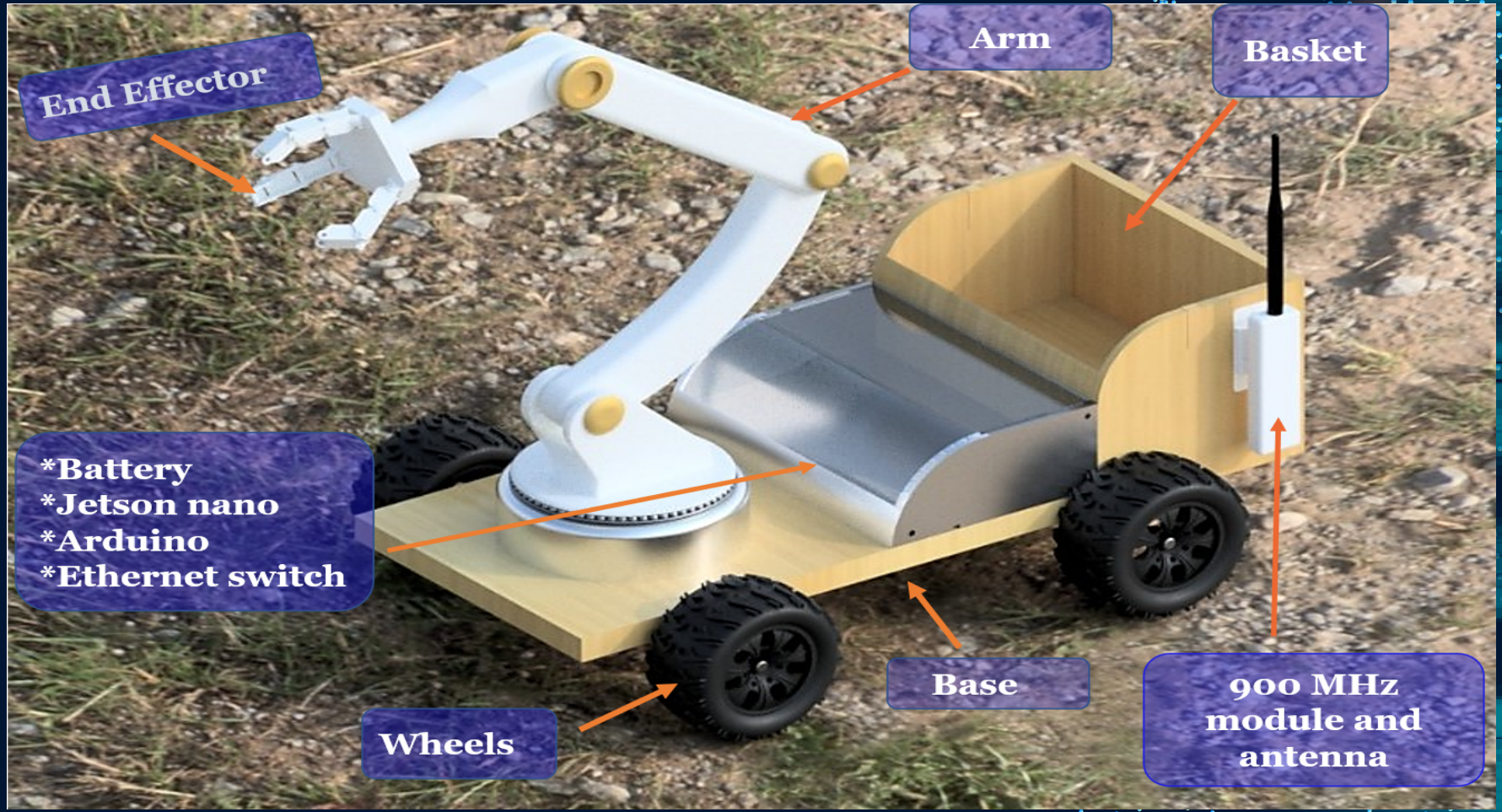
TORMINATOR

THE ROBOTIC ARM



GOAL

➢To study the behavior of a 6-DOF robotic arm and to develop a high precision pick-up & drop Bot
➢To design the robotic arm such that it carries out various activities like picking ripe tomatoes, etc


End Effector
Arm
Basket
*Battery
*Jetson nano
*Arduino
*Ethernet switch
Base
900 MHz module and antenna
Wheels

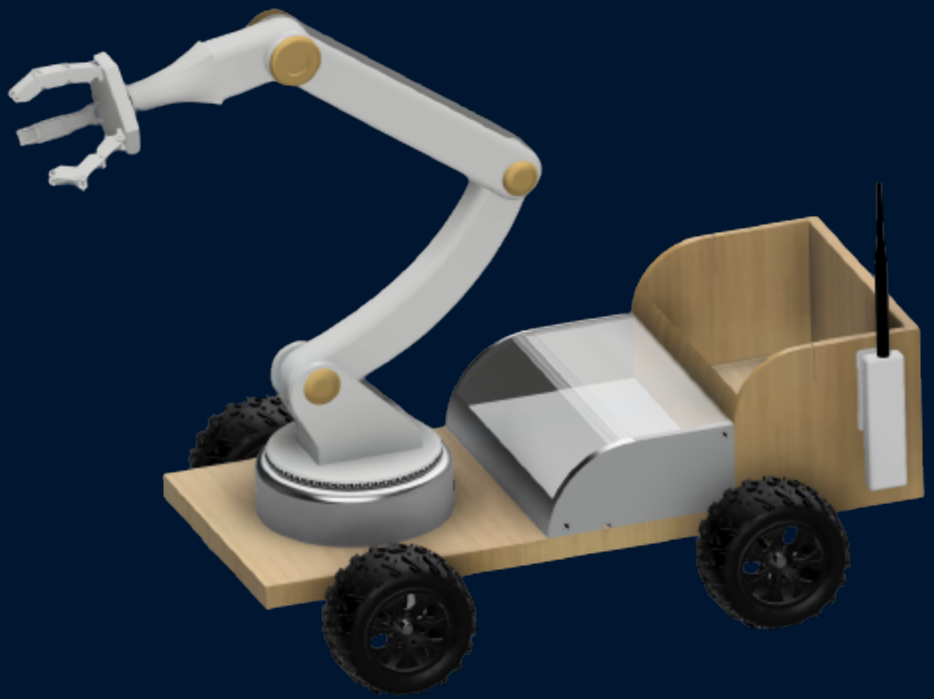
PLATFORMS USED

AUTODESK® FUSION 360™

- Modeling
- Rendering

unity

- Simulation
- Environmental Design



MECHANICAL MODULE

- Robotic Arm
- End Effector
- Wheels

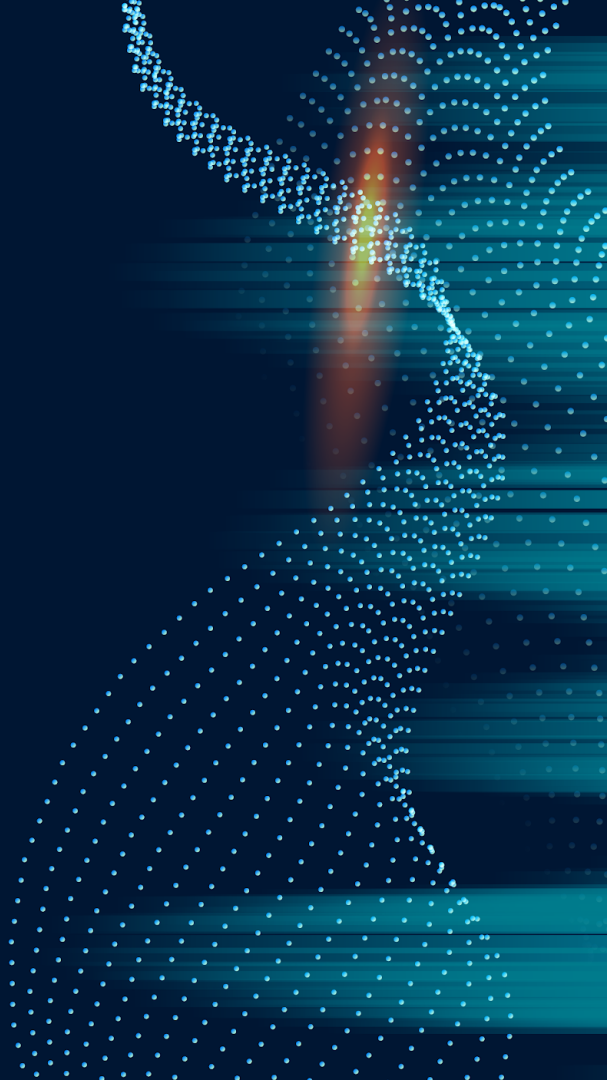
ROBOTIC ARM

>MECHANICAL DESIGN

➢Aluminium is used as the main material because it is light in weight which makes it convenient for portability and also it has great strength.

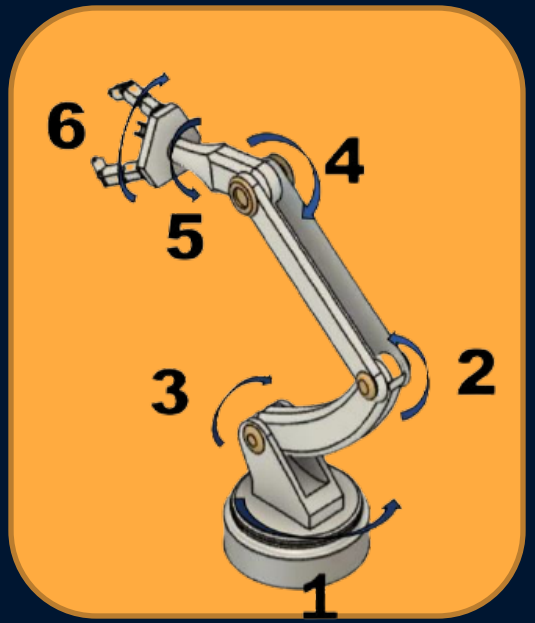
➢Ball bearing is used at the bottom of the robotic arm along with a servo motor to provide 360-degree rotation to our robot and to have minimal resistance when the upper arm will rotate.

➢For the base of the robot a cylindrical steel base is chosen to provide stability over the flat surface of an automated vehicle.



ROBOTIC ARM

>MOTORS INFO

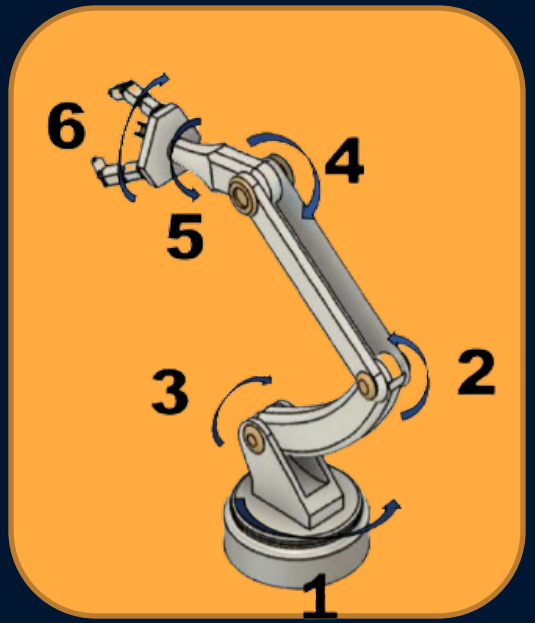


7 servo motors and 1 DC motor for the movement of the robotic arm.

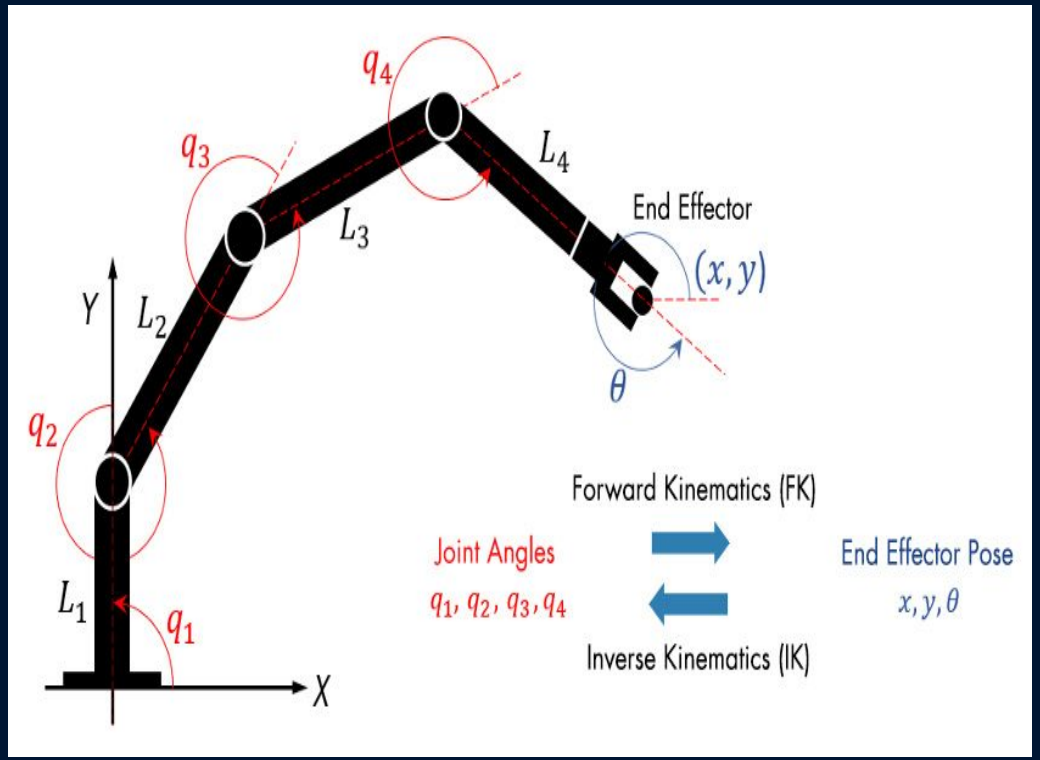
- Ø 3 high torque motors for the movement of the arm
- Ø 3 micro servos, one for each finger of the end effector
- Ø 1 complete rotation servo for the base of the robotic arm
- Ø 1 DC motor for the rotation of the wrist

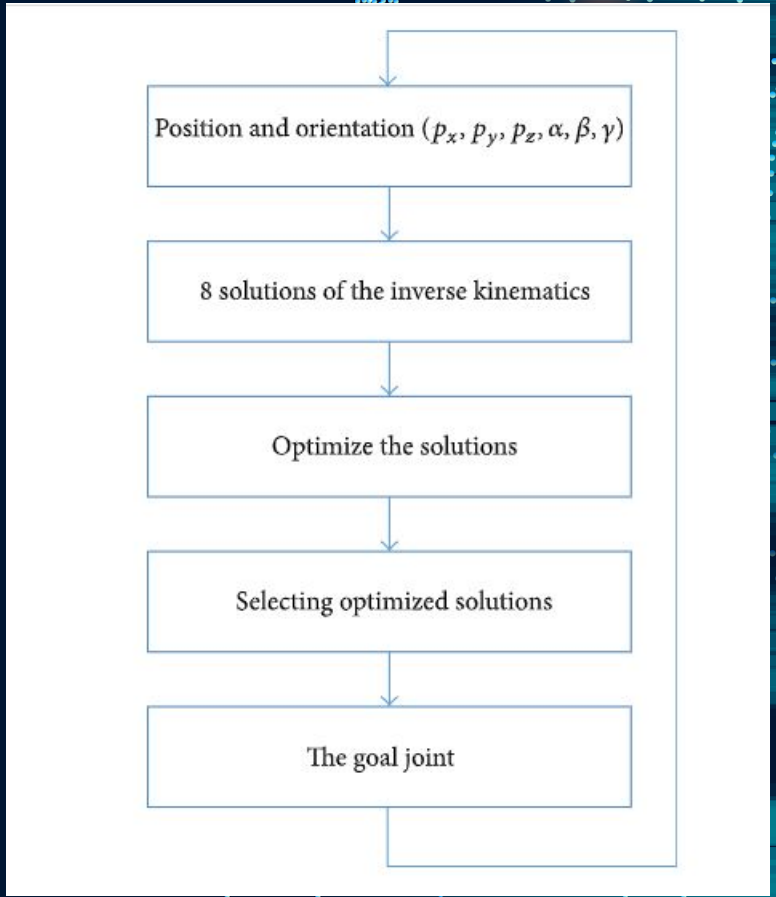
ROBOTIC ARM

>WORKING (INVERSE KINEMATICS)

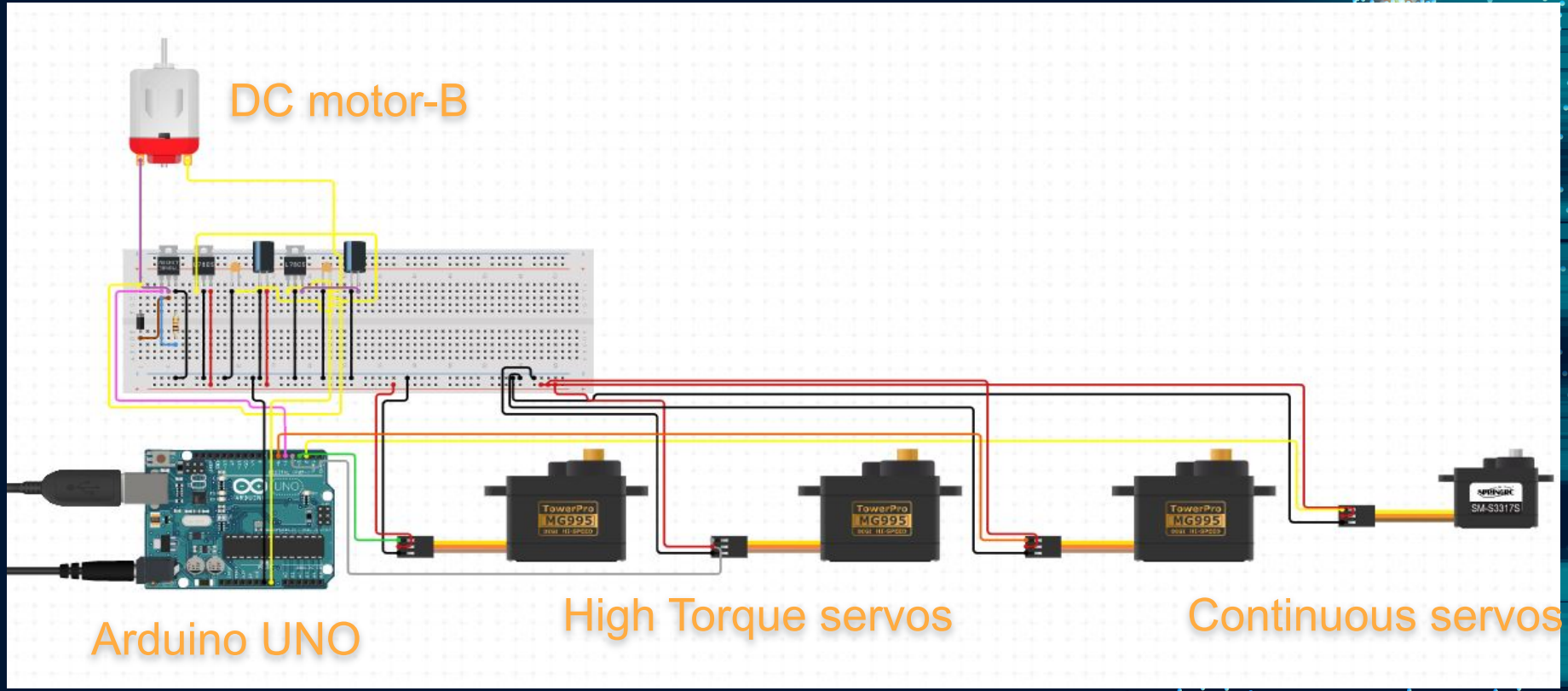


- Ø A reliable **inverse kinematic** solution is used for programming the robotic arm to perform tasks
- Ø Inverse kinematics is a mathematical process used to calculate the joint positions that are needed to place a robot's end effector at a specific position and orientation (also known as its "pose")


q_4
q_3
L_4
L_3
End Effector
(x, y)
Y
L_2
θ
q_2
Forward Kinematics (FK)
Joint Angles
q_1, q_2, q_3, q_4
End Effector Pose
x, y, θ
Inverse Kinematics (IK)
L_1
q_1
X

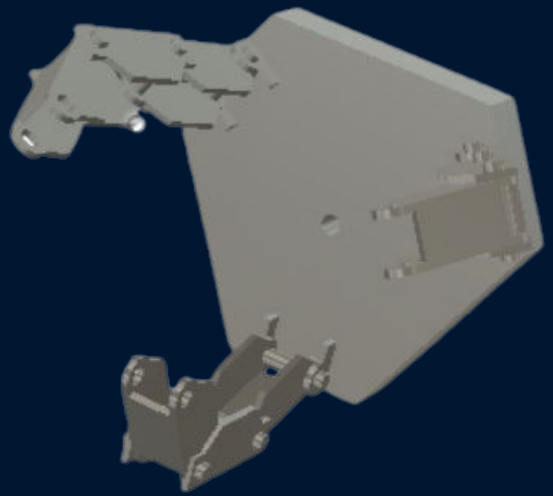

Position and orientation $(p_x, p_y, p_z, \alpha, \beta, \gamma)$
8 solutions of the inverse kinematics
Optimize the solutions
Selecting optimized solutions
The goal joint

>ARDUINO CIRCUIT - ARM



END EFFECTOR

>STRUCTURE



➢Three-fingered gripper comprising fingers, a back plate, thread and finger bending mechanisms.

➢Each finger has 4 sections. . Joints between the sections are flexible and provide cushioning while grabbing the objects

END EFFECTOR

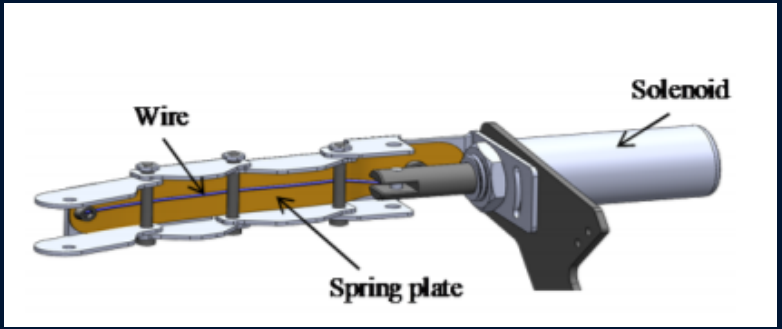
>WORKING

➢Each Finger has three joints and connect from a thread and thread is connected to a servo when servo rotate finger bends and reducing the opening of the tip.

➢While picking a Tomato End Effector will rotate with a defined Angle and speed and that jerk will cut Tomato from Plant.

END EFFECTOR

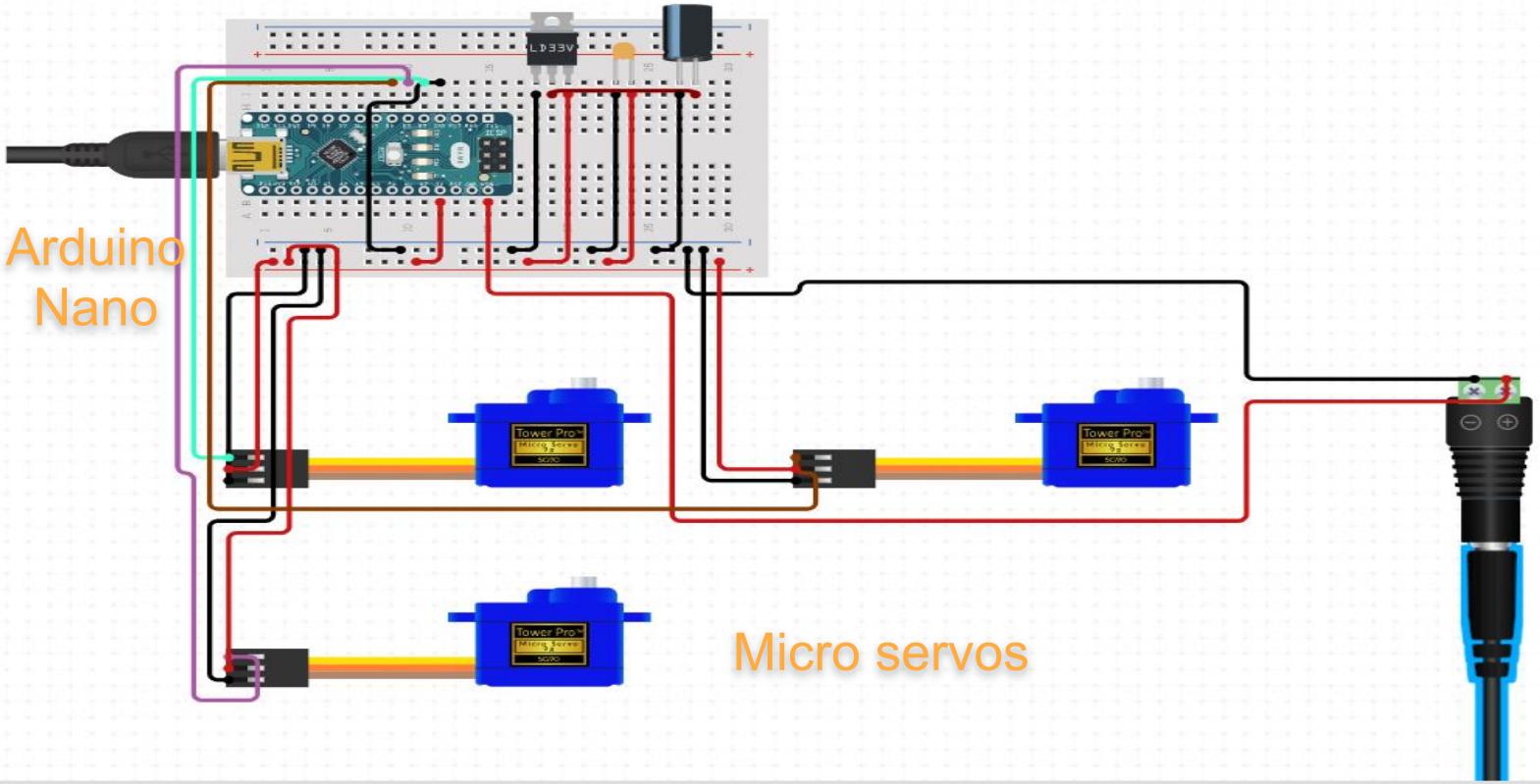
>BENDING MECHANISM



➢ One thread is connected to the tip in each of the fingers and in other end it is connected to a servo. When servo rotates it pulls the thread in the inside of the finger, drawing the tip in and make finger joints to bend.

➢ When the three fingers curl together, the opening of the tip of the end-effector shrinks, enhancing its grip on the Tomato

>ARDUINO CIRCUIT – END EFFECTOR



WHEELS

>RIM

Alloy wheels instead of steel or chrome rim are used for the system because:-

- Alloy rims are made from aluminium or magnesium or both. They have less weight when compared to steel rims.
- There will be less strain on the suspension of the system. Alloy rims add much to the good look of a system.

WHEELS

>OUTER SURFACE

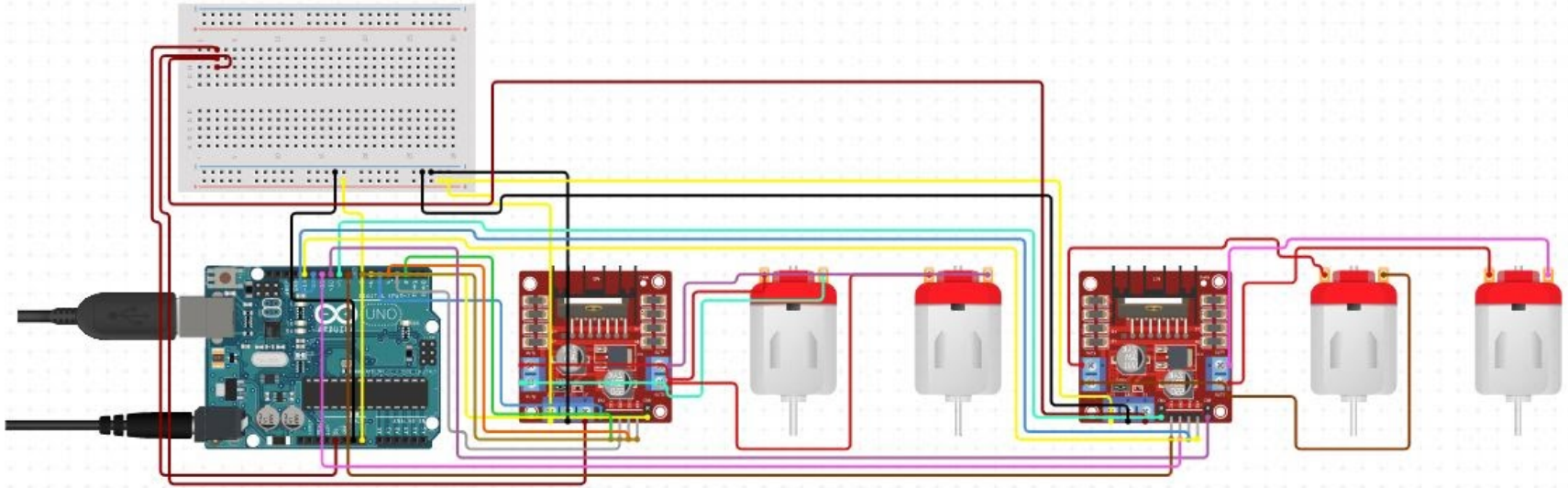
- The outer surface of tyre is designed with a periodic wavy spikes pattern over the whole surface with the intent to increase friction and grip with the plains and help in smooth travel of the bot.
- This pattern avoids any growth cracks and is proved to be nice for plains surface.

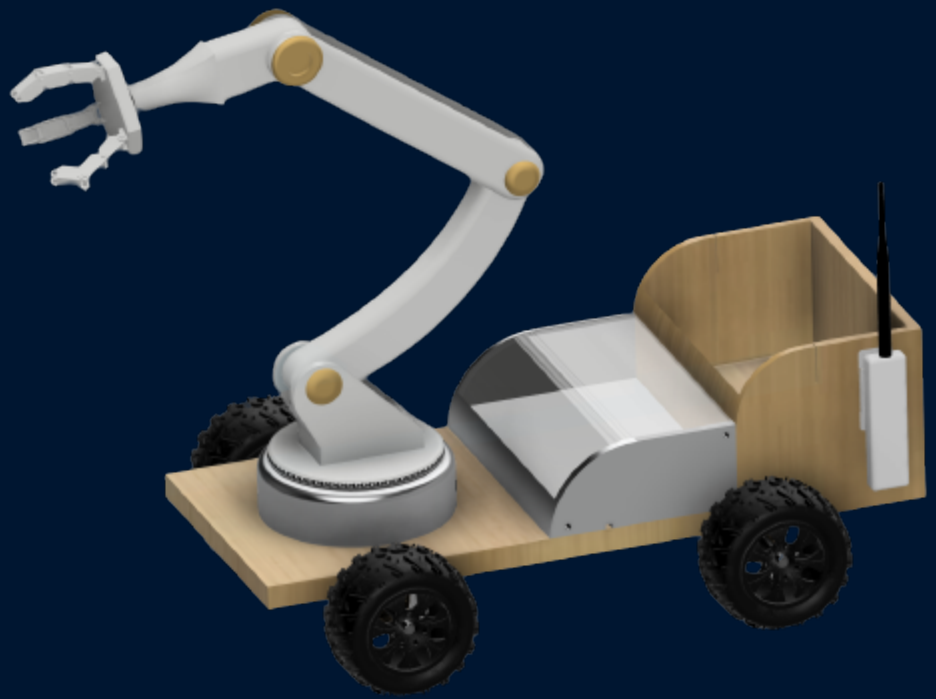
WHEELS

>TORQUE AND MOTOR INFO

- 4 12v dc gear motor are used for the wheels, which offers a range of 0.29 Nm to 1.47 Nm which fulfil our requirements .
- It provides a speed of 1.1 rpm to 1000 rpm to the wheel so that the robot moves with a desirable speed.

>ARDUINO CIRCUIT - WHEELS





ELECTRICAL MODULE

- Power
- Communication
- Controlling

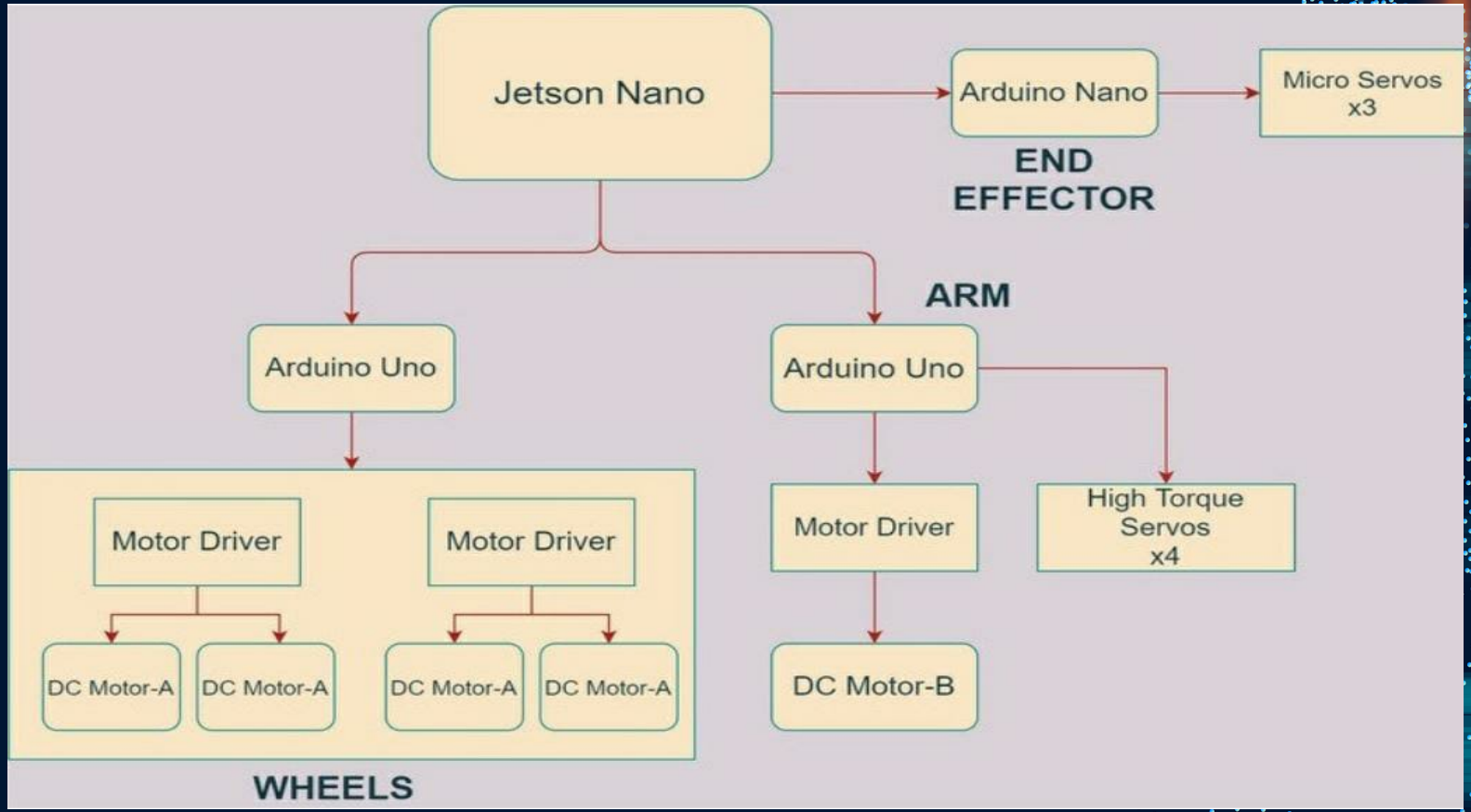
POWER

- We have used 4 Lithium-ion Batteries operating the whole bot.
- Each battery is of rating 2.2Ah(Amp hour) providing an output voltage of 11.1~12V.
- The batteries are chosen to make the whole system operable for 2 hrs per single-use and it takes approx 2.5 hours to recharge each battery with 10A current.

COMMUNICATION

- A 900MHz radio band is used for interaction between driver and robotic arm system
- The arm is equipped with a whip antenna 5 dbi & pico station module and the driver will control the wheels and rover with a game controller/two joysticks through an omnidirectional antenna equipped with a pico station module to communicate with the robotic arm
- This system works within a range of 1km (LOS) and 750m (Non-LOS) feasible for large farms in India.

CONTROLLING FLOWCHART



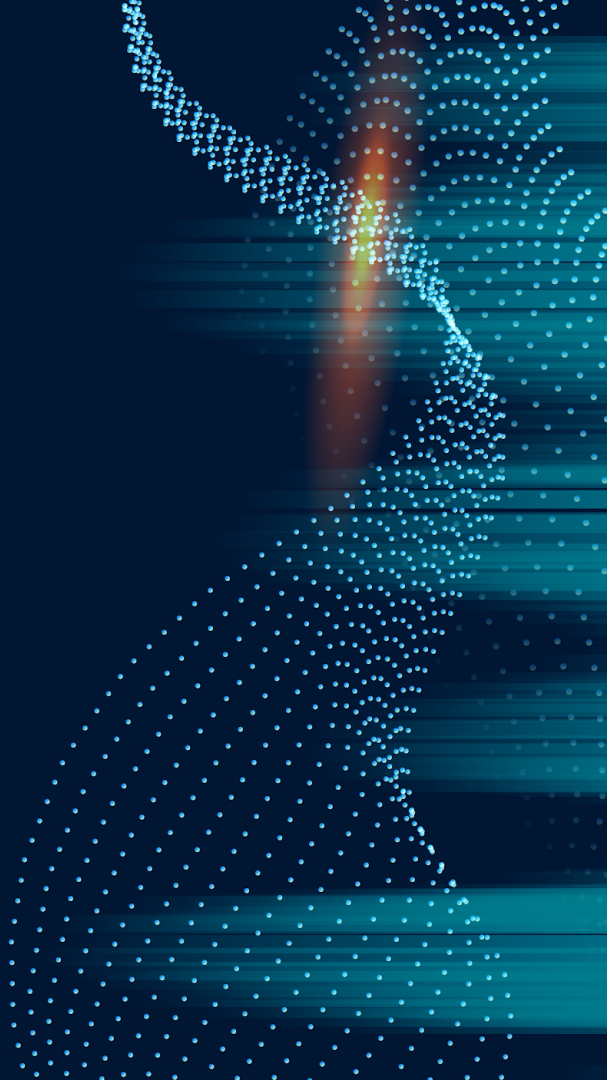
BILL

S no.	Components	Specification	Quantity	Price per unit (in Rs)	Total Price(in Rs)
1	DC Motor A	Operating Voltage-12V,Stall Torque-15kgcm,speed-1.1-1000rpm,dimension-10x10x20mm	4	275	1100
2	High Torque servo motors	Operating Voltage-4.8~5V,Torque-10kg cm,Operating speed-0.13s,Current comsumption-2A	3	350	1050
3	Small SG90 Servo	Operating Voltage-4.8V~6.0V,Torque-1.6kg/ cm,Operating ,Weight: 9g	3	130	390
4	DC Motor B	Operating Voltage-12V,Stall Torque-15kgcm,speed-1.1-500rpm,Dimension-10x10x20mm	1	275	275
5	High Torque servo motors	Operating Voltage-4.8~5V,Torque-10kg cm,Operating speed-0.13s,360 degree Rotation	1	350	350
6	Motor Driver	L293 Motor driver	3	115	345
7	Ethernet Switch	Dimension-119x89x30mm, 4-port Gigabit Ethernet PoE Switch,Power-60W, Wifi type-802.3af	1	360	360

8	Nvidia Jetson Nano	GPU-128-core Maxwell CPUQuad-core ARM A57 1.43 GHz,Memory- 2GB 64-bit LPDDR4 25.6 GB/s	1	4500	4500
9	Arduino UNO	14 digital input/output pins , 6 analog inputs,a 16 MHz ceramic resonator,	2	500	1000
10	Arduino Nano	Arduino Nano V3,14 digital input/8 analog inputs,	1	295	295
11	LiPo Pattery	Dimension-128x64x43mm,Voltage-12V,Nominal	4	1549	6196
12	Module+Antenna	5dBi whip antenna+M9 picostation module,data speed-100+Mbps, range-1-1.5km	1	800	800
13	Remote controller	Equipped with antenna, Range-1km,Frequency-900MHz,6 channels,2Joysticks	1	1100	1100
14	Aluminium		4.353kg	135/kg	588
15	Steel		2.943kg	195/kg	573
16	Wood	Oak Wood	4.179kg	93/kg	388
				TOTAL COST	19310

FUTURE PROSPECTS

- Can be made totally autonomous using OpenCV.
- Carbon fibre can be used instead of Aluminium for commercial purposes.
- Can be expanded to harvest horticulture crops like Brinjal, Oranges etc.
- Solar panels of 120W power output can be used to recharge batteries.



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- Zongxing Lu, Chunguang Xu (2015). Inverse Kinematic Analysis and Evaluation of a Robot for Nondestructive Testing Application
- Y. C. Chiu, P. Y. Yang, S. Chen (2010). Development Of The End-Effector of a Picking Robot For Greenhouse Grown Tomatoes

NOW WE ARE SHOWING SIMULATION OF THE PROJECT

THANKS!

Do you have any questions?