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Robox: Optimised Robot For Lifting Soccer Ball And Place It At A Distance

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Abstract— **Today's technology of robotics and automation has reached enormous advancements. In this research paper we did the designing, calculation and analysis of the robot according to the given problem statement. The problem statement was specified but we had the target to do the designing with simplest usage of mechanism as well as weight reduction. So, for this we used software such as SOLIDWORKS and ANSYS.**

Keywords—Ansys, CAD model, Solidworks,

I. INTRODUCTION

Objective of this project is to create a robot which will be receiving a football coming with a velocity of 4m/s, take it to a box which is at 5000mm and then drop it into the box whose height is 300mm. To stop the ball, we have designed two structures keeping in mind that the ball can come either rolling on the ground or in a projectile motion. For rolling, we have designed a see-saw shaped structure which will allow to stop the ball inside our robot but won't let it get away from it. For projectile motion, we have used a net mounted on a goal-post kind of structure which will stop the ball and drop it in desired place. To take the robot to a height of 300mm, we are going to use a conveyor belt, inclined at an angle, so that to ball reaches the height of 300mm and the belt will also be the one dropping the ball into the box. For locomotion of the robot, we are using standard robot wheels of diameter 130mm.

II. WORKING METHODOLOGY

A. Selecting the mechanism:

We decided two mechanisms, first the one we chose and the second was to stop the ball and use a robotic arm to pick it up and put it into a box. We decided on first one because it's working was much simpler and implementation was easier as well.

B. Design and Analysis:

To support the bot, we have made a 4-wheel Aluminum chassis of dimensions 902mmx600mm and mounted a wheel assembly with wheels having diameter of 130mm. We have designed a football goalpost like structure having a net to stop the ball and drop it in desired place. We have also made a see-saw shaped structure to stop ball (which will come rolling with a speed of 4m/s). There is enough space in between the start of belt and end of see-saw shaped structure for ball to rest (assuming diameter of ball to be 250mm). We have made a structure to support the belt and support for ball to go up and mounted this structure on the 4-wheel chassis. Belt is going to work with the help of a DC motor. We have also made an inclined support of **sheet metal (584x301)** for the ball to go up and have attached two rotors at the end of it (near the ground) for the ball to easily get on the support.

III. DETAILED WORKING

When the ball is rolling on the ground, it will come towards the see-saw shaped mechanism and will start climbing on it. Once it crosses the halfway of see-saw, the part where ball is going towards will start to go down and once the ball crosses the see-saw, it will return to its normal position. There is some space in between the see-saw and belt so the ball will be contained there. In case the ball is coming in projectile, there is a football goalpost like structure having net on three sides of it. When ball hits the net it's speed will decrease and then it will fall in the space we have left. Even if the ball bounces, it will remain in the space and won't go out of the structure. Once the ball comes to rest, the rotors will help to get the ball on the inclined surface. Once the ball is on inclined surface, we will move the robot and take it to the box at a distanced on 5000mm and of height 300mm. Once the robot reaches the box, the conveyor belt will start rotating and take the ball upwards on the inclined, and on reaching the end of inclination, the belt will keep on rotating and will drop the ball into the box.

A. Electronic Parts :

Four DC motors (12-24V) for wheel having torque of 110.5kgcm or more and a RPM of more than 400, 2 DC motors(24V) for belts, Circuit board, proximity sensor, ultrasonic sensor. Components: DC Motors, Circuit board, wires, sensors Units

B. specifications

Components	Specifications
4 DC motors	12-24V, torque>=110.5kgcm, RPM>=400
2 DC motors	24V, torque>=80kgcmt
Proximity Sensor	Range=2-4mm
Ultrasonic Sensor	Range=4-5m
2 DC motors	12V, Torque>=6kgcm

IV. CALCULATIONS

A. For locomotion motors:

Mass of the bot: 17kg
Acceleration: 2m/s2
Force = ma
= 17*2

= 34 N

Since there are 4 motors, so each motor should supply 34/4 N or 8.5 N of force

Distance (for torque) = Radius of wheels = 65mm or 6.5cm

Torque = F*d

= 8.5*6.5

= 55.25 kgcm

Due to margin for friction and inefficiency in power transmission, taking factor of safety as 2, we get

Required torque = 55.25*2 = 110.5 kgcm

RPM:

Diameter = 130mm or 0.13m

Circumference = pi*d = 0.41m

Assuming required velocity of robot as 10 km/hr or 2.7m/s

RPM = (2.7/0.41) *60 = 395.1

RPM = 400 (rounding off) Some Common Mistakes

B. For belt drive:

Radius = 50 mm

Mass of belt = 4kg

Acceleration = 2 m/s2

Torque = 4*2*0.05 = 0.4 or 40kgcm

Taking factor of safety 2, we get

Torque = 80 kgcm

RPM:

Diameter = 100mm or 0.1m

Circumference = pi*d = 0.315

Assuming belt velocity to be 2m/s,

RPM = (2/0.315)*60 = 381RPM

C. For rotors:

Mass = 0.3kg

Radius = 101mm or 0.1m

Acceleration = 1 m/s2

Torque = 0.3*0.1*1 = 0.03 or 3kgcm

Taking factor of safety as 2, we get

Torque = 6kgcm

RPM:

Diameter = 202 mm or 0.2m

Circumference = pi*d = 0.63m

Assuming velocity of rotor to be 1m/s,

RPM = (1/0.63)*60 = 96RPM

V. INSIGHTS

A. Problems faced while deciding mechanism of robot-

- Deciding which mechanism to go with, conveyor belt one or the one with robotic arm
- How to stop the ball coming with a velocity of 4m/s or in a projectile.
- How to take the ball to a height of 300mm (meaning whether to keep conveyor belt vertical or to keep it on inclination.

B. Problems faced while designing the robot-

- What dimensions to take.
- How much inclination should we give to support and the belt.
- Specific designs of chassis and parts.
- How to stop the ball coming in projectile.

C. Measures taken to overcome them-

- Conveyor belt mechanism was decided due to the ease of stopping the ball and, we don't need to control the robotic arm.
- We decided on a see-saw shaped mechanism to stop the ball, if it is coming while rolling on the ground, and a goalpost like structure with net to stop a ball coming in a projectile motion.
- Conveyor belt and support were given an inclination as a vertical conveyor belt would have required more power to take the ball vertically up and weight was more balanced in keeping the belt inclined.
- Dimensions were decided keeping in mind the dimension of ball and max. dimensions of robot.
- Inclination of belt was decided on basis of its length and part designs were modified during the assembly to incorporate the changes.

D. Point of Special Mention

We were only considering the ball to be coming from ground so when we found out that it may come in projectile motion as well, we tried to incorporate goalpost like structure and see-saw mechanism in a single bot. But we could have also made two different designs, one with see-saw mechanism and other with goalpost like structure.

RESULT

In this way, ROBOX was designed with the help of software such as SOLIDWORKS. and the analysis was done in software called ANSYS. According to the problem statement we designed it in the most optimized way with respect to weight reduction and within given dimensions of 1000mm x 1000mm.

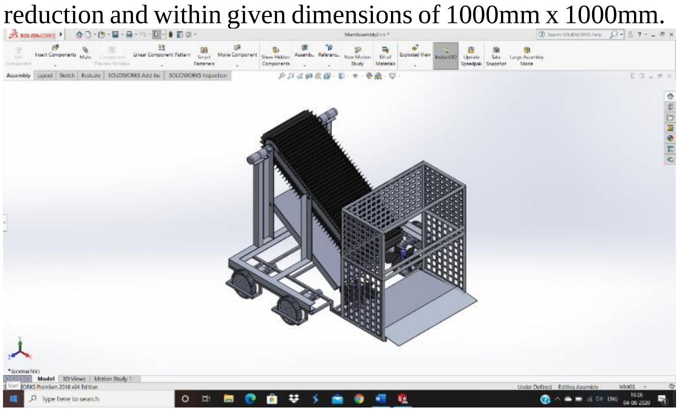

Fig. 1: CAD Model

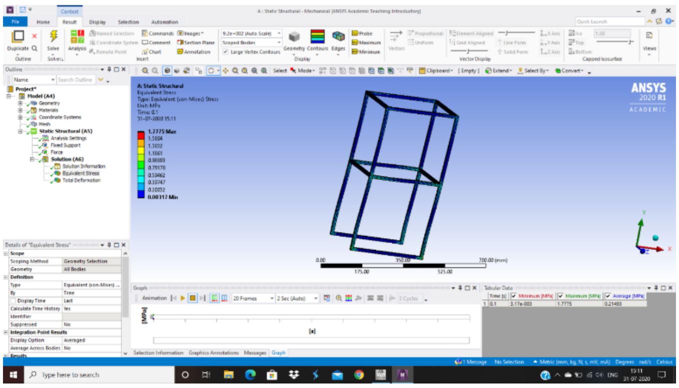

Fig. 2: Analysis result of Basket skeleton

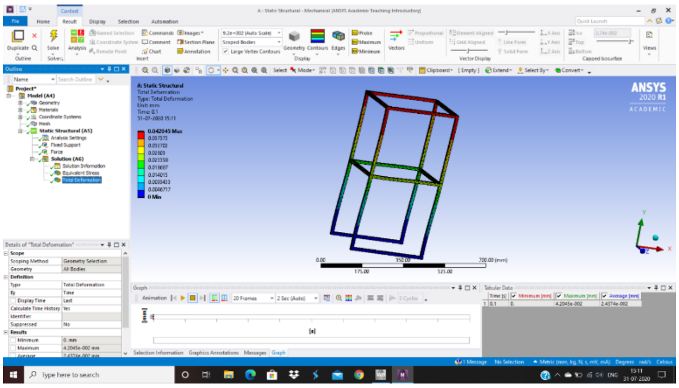

Fig. 3: Total deformation result of Basket skeleton

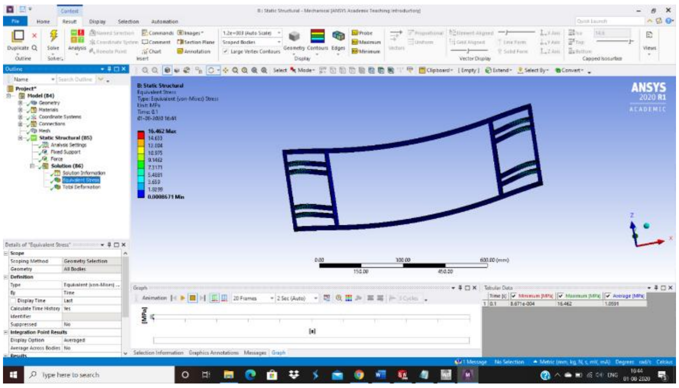

Fig. 4: Analysis result of Base

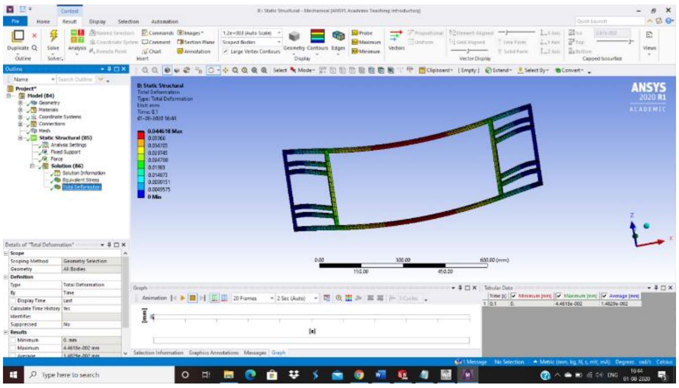

Fig. 5: Total deformation result of Base

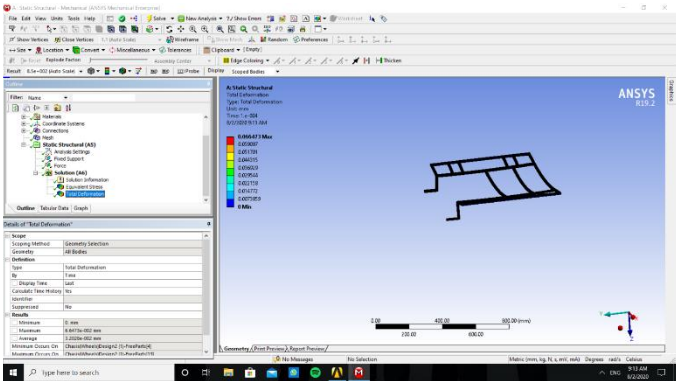

Fig. 6: Total deformation result of Chassis

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