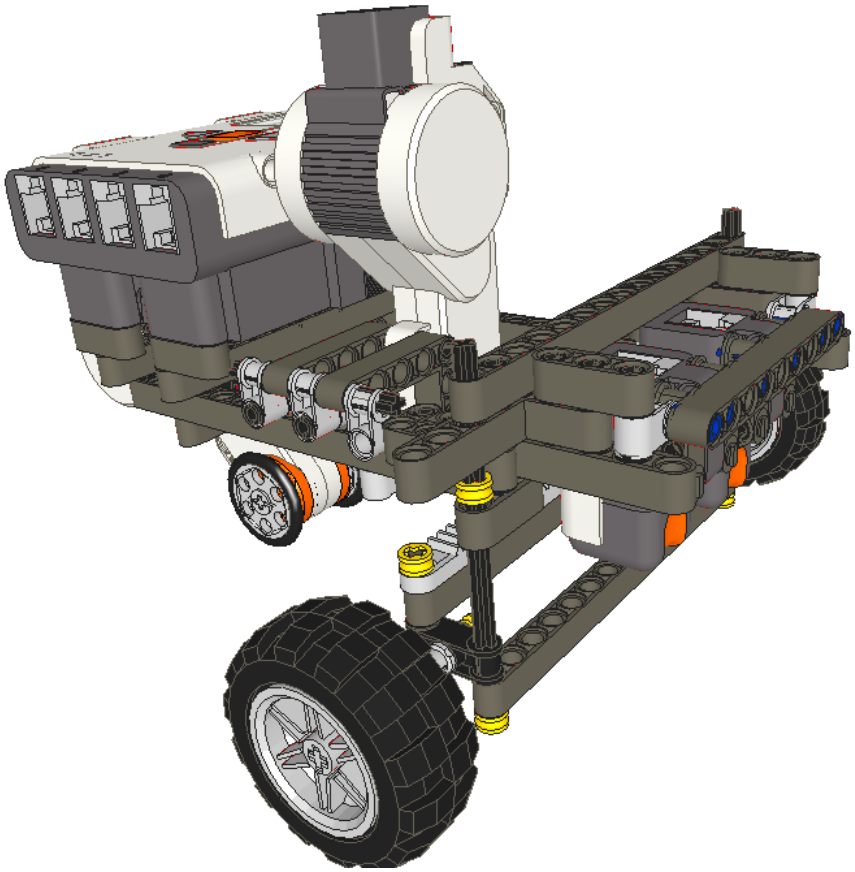
Lego NXT Line Follower

Instructions for

Building
and Controlling



By Russell Smalley

Contents

1. Description of Kit

The NXT line following experiment is comprised of two pieces of hardware and one piece of software. The hardware consists of a line following robot constructed from Lego pieces and a line track used to tune and then test the capabilities. The software is an interface developed within the LabView programming environment and is used to set the control parameters. The software must be installed on a Bluetooth enabled machine to use the wireless function.

The robot device uses two servo motors, one to propel it forwards and backward and a second to steer the wheels to an accuracy of one degree. The robots position relative to the line is measured using two infer-red sensors and emitters. This is achieved by measuring the contrast difference between the two sensors. This means any line contrasting to the background can be followed, but optimal response is achieved from a white background and a black line.

2. Components Glossary

Rods:

2 x (1x10)

1 x (1x8)

1 x (1x6)

3 x (1x5) grey

1 x (1x4)

Joints:

13 X Light grey angled joints

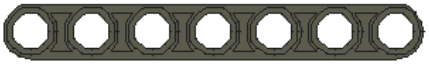
4 X Dark grey angled Joints

4 X Black angled joints

Bars:

8 X (1x3)

2 X (1x7)



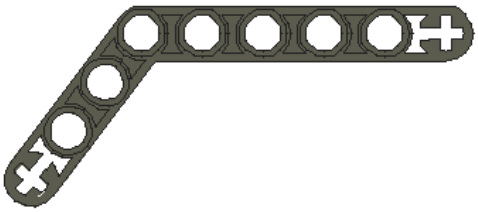
2 X (1x9)

2 X (1x11)

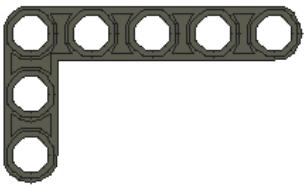
2 X (1x13)

5 X (1x15)

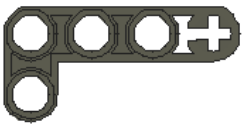
2 X (6x4) angled



5 x (5x3) angled



2 x (4x2) angled



Connectors:

2 X Red connectors

20 X Blue connectors

43 X Black single connectors

15 X Black double connectors

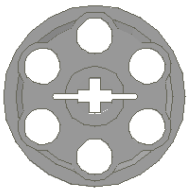
Fasteners:

2 X grey fasteners

10 X yellow fasteners

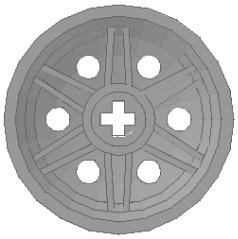
Wheels/tyres:

2 x Small wheel

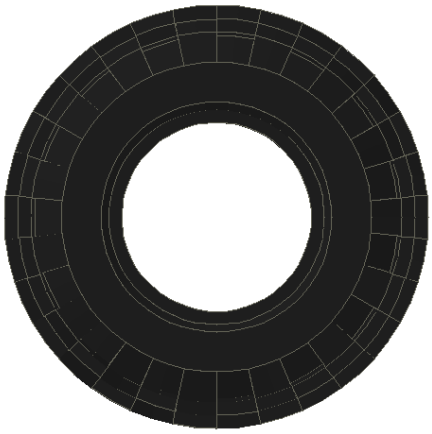


2 x Small tyre

2 x Large wheel



2 x Large tyre



Rack/pinion:

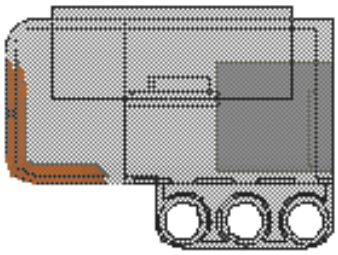
1 X Rack (1x14)

2 x Pinions

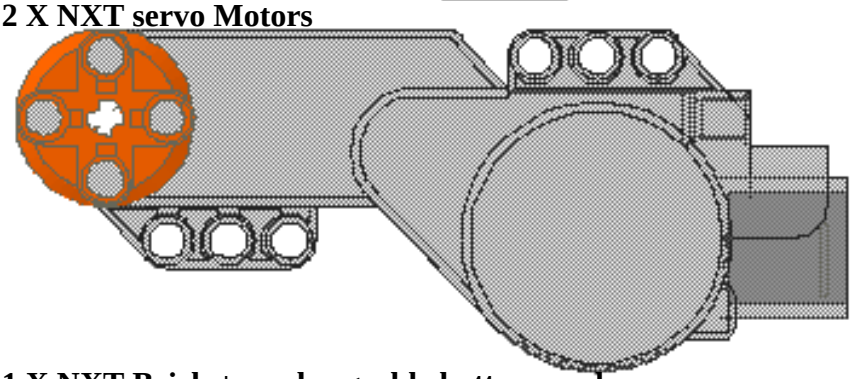
NXT components:

4 X NXT connecter cables

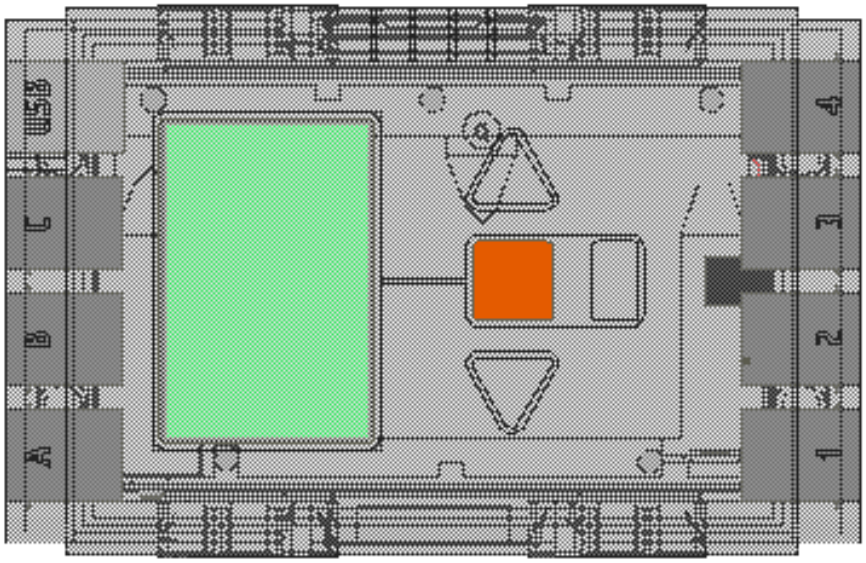
2 X NXT colour sensors



2 X NXT servo Motors



1 X NXT Brick + re-chargeable battery pack



3. LABVIEW Installation Guide

Assuming Labview base package is installed with the additional control design and simulation toolbox, there is only one addition required. This is the “NI LabVIEW Toolkit for LEGO MINDSTORMS NXT 2.0” developed by National Instruments and downloadable free from their website. This toolkit contains all of the standard functions designed to communicate directly with the NXT brick.

This toolkit contains all of the standard functions designed to communicate with the NXT brick. There are two versions of the software one is compatible with Labview 8.5 and the other with 8.6 all files including the NXT firmware must be from the corresponding Labview folder. The line follower folder contains:

- BTM Send.vi -Both ver.8.5 and ver.8.6
- cdEx_Implement_Parallel_PID.vi -Ver.8.6
- Line Follower BT.vi -Both ver.8.5 and ver.8.6
- Line Follower USB .vi -Both ver.8.5 and ver.8.6
- NXT Line Follower.vi -Both ver.8.5 and ver.8.6
- LEGO MINDSTORMS NXT Firmware V1.26 -Both ver.8.5 and ver.8.6

4. Construction Guide

The Line following robot is built up of seven modules. Once these are constructed they will be put together to form the completed robot. To begin with we will start with the chassis.

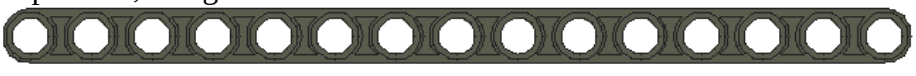
4.1. Chassis

1.

2.

Assemble the chassis as shown in the pictures, using:

3 x (1x15)

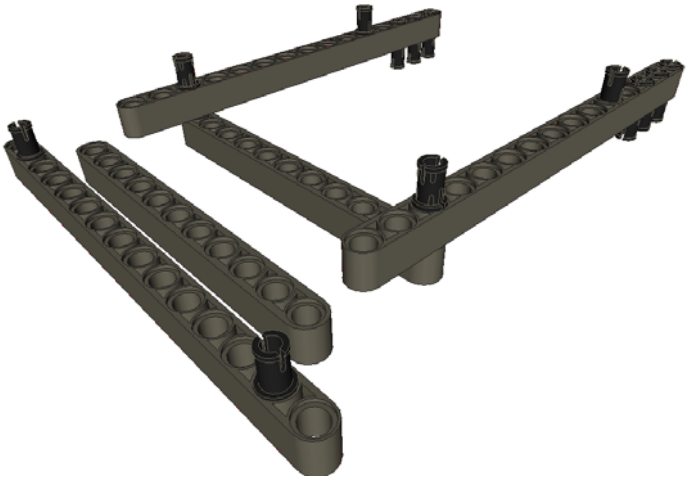


2 x (1x11)

10 x black single

2 x black double

3.



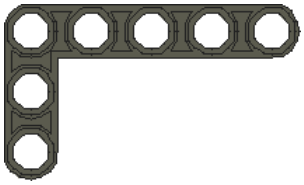
4.

The two extra bars will be used later.

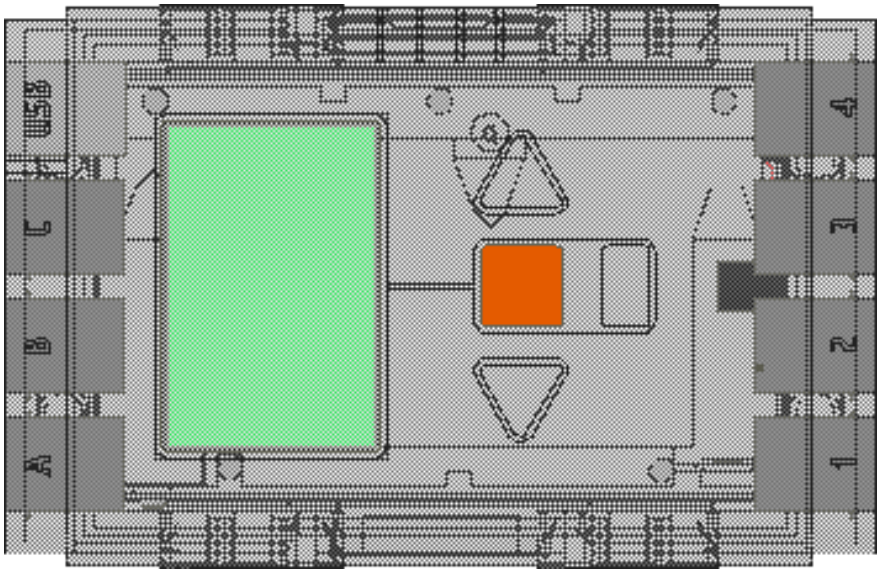
4.2. Controller

Attach a (3x5) angled bar to the right side of the NXT brick with 4 black single connectors as shown.

1 x (3x5)

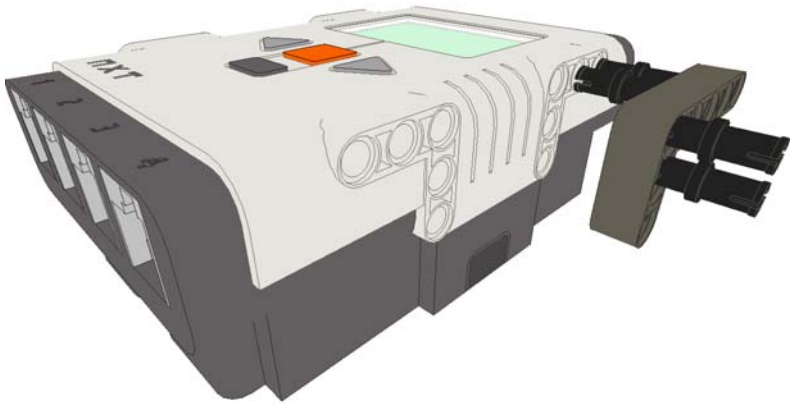


1 x NXT brick

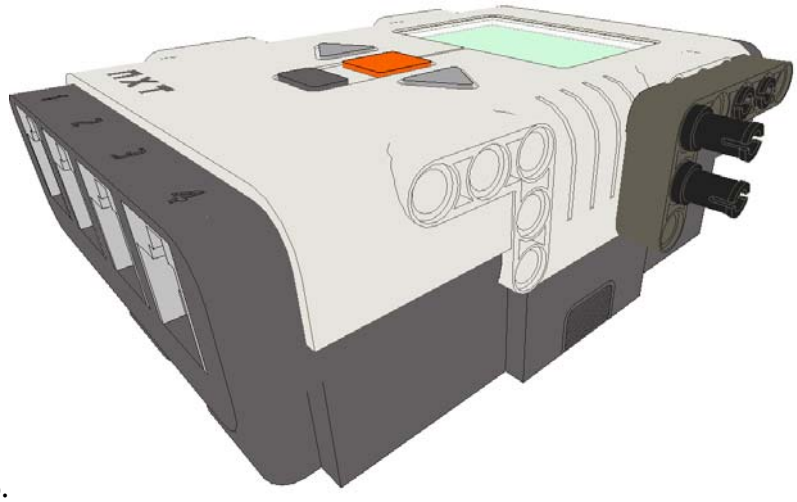


4 x black single

5.



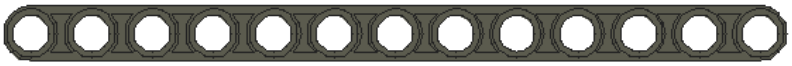
6.

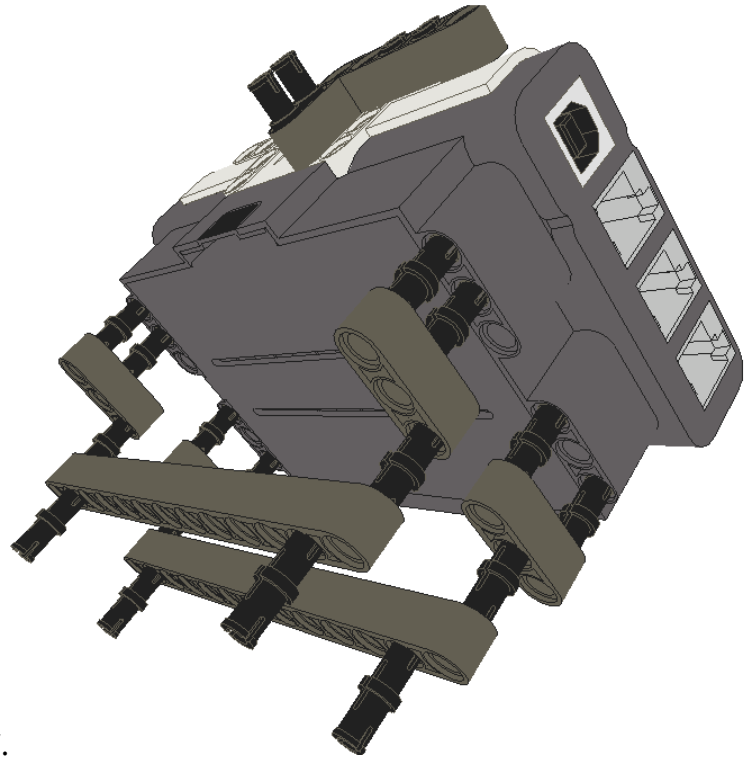


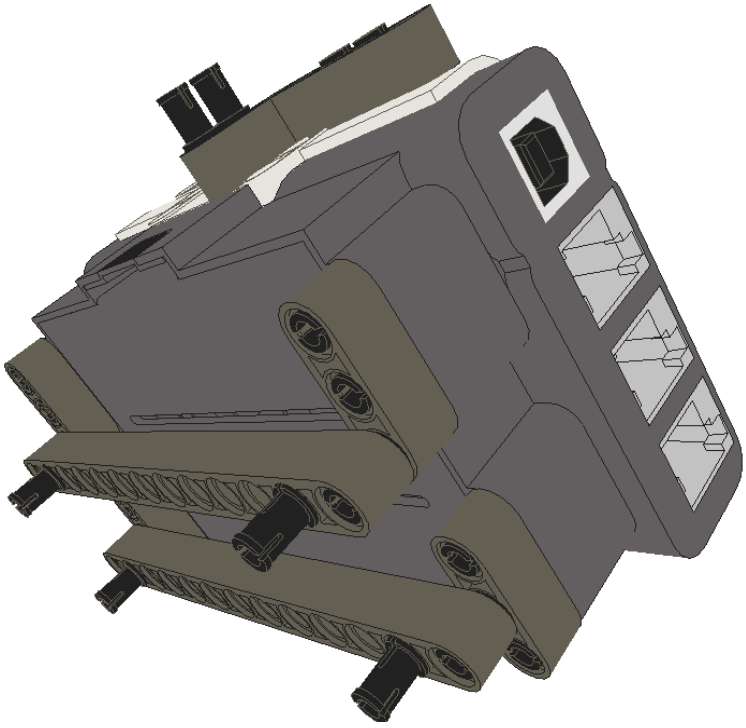
Using 16 x black single connectors to attach 4 x (1x3) bars and 2 x (1x13) bars, as demonstrated below.

16 x black single 

4 x (1x3) 

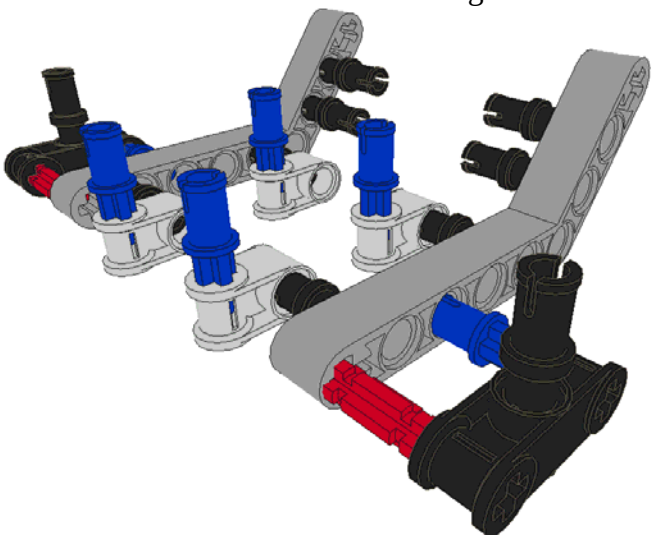
2 x (1x13) 

7. 

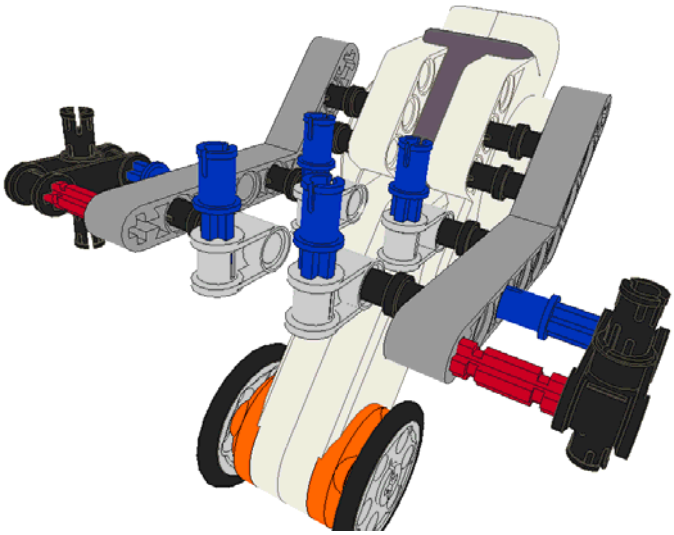
8. 

4.3. Drive motor

This is the frame used to hold the driving motor to the chassis.



9.



10.

8 x black single connectors

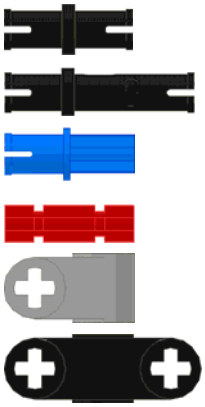
2 x black double connectors

6 x blue connectors

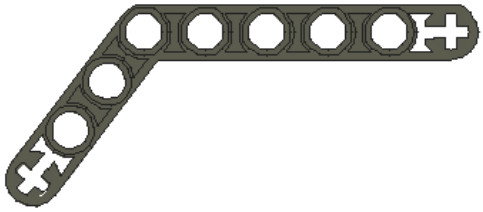
2 x red connectors

4 x light grey angled joints

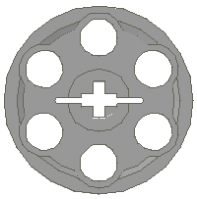
2 x black angled joints



2 x dark grey (6x4)



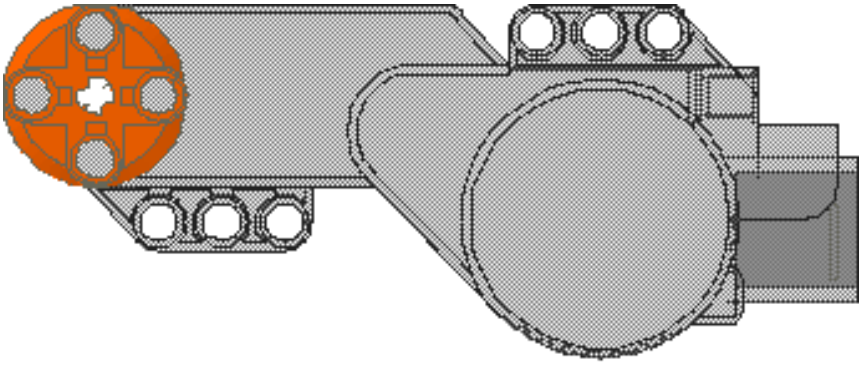
2 x small wheels

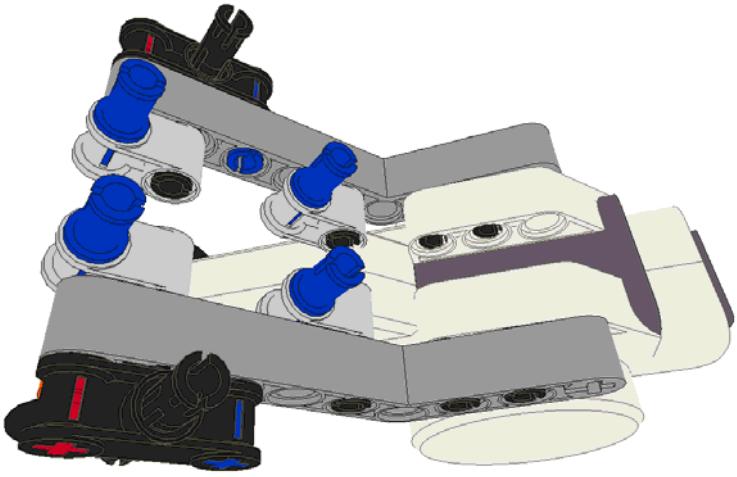


2 x small tyres

1 x (1x5) grey rod

1 x NXT servo





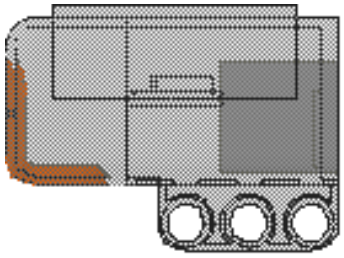
11.

4.4. Sensor

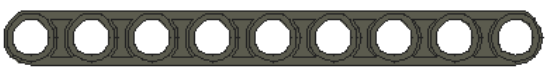
This is the frame used to hold the two sensors together.

4 x black double connectors
4 x blue connectors
4 x dark grey angled joints

2 x NXT colour sensors



1 x (1x9) bar



12.

13.

4.5. Steer motor

This frame will hold the servo motor which controls the steering to the chassis. You will need,

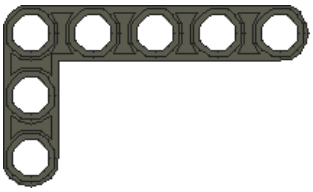
7 x light grey angled joints

2 x black single connectors

2 x black double connectors

4 x blue connectors

2 x (3x5) angled bars



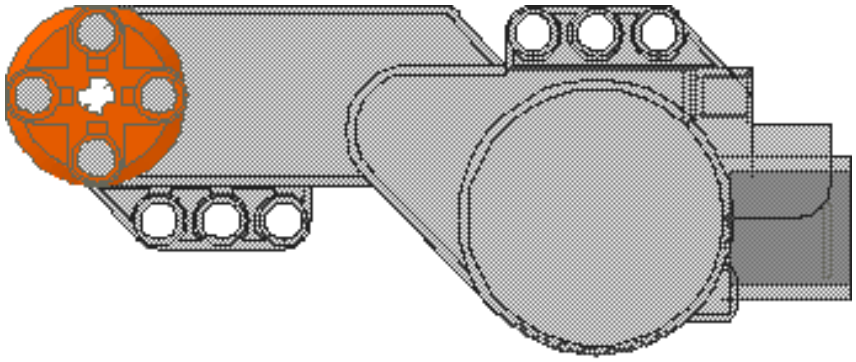
1 x (1x9) bars

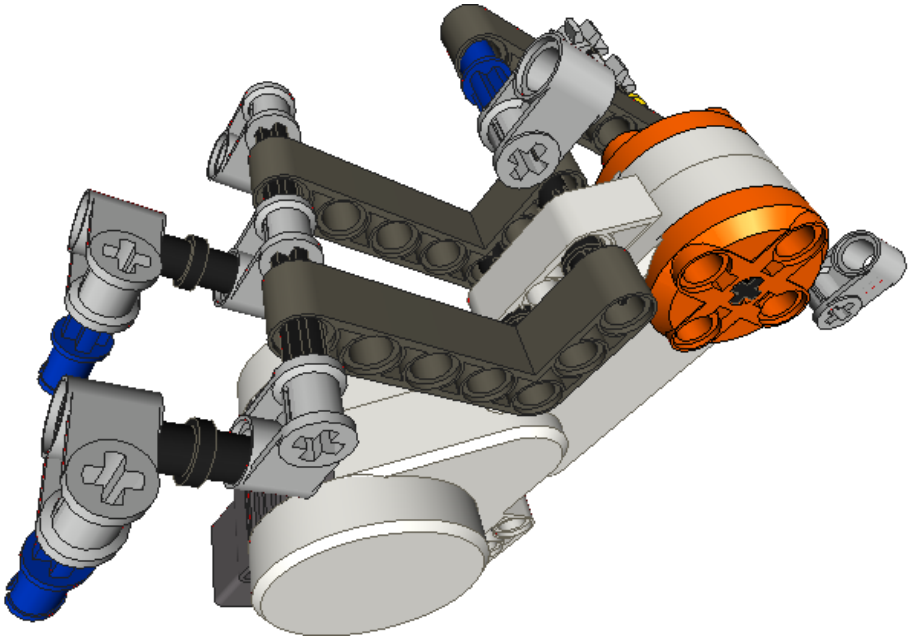
2 x pinion cogs

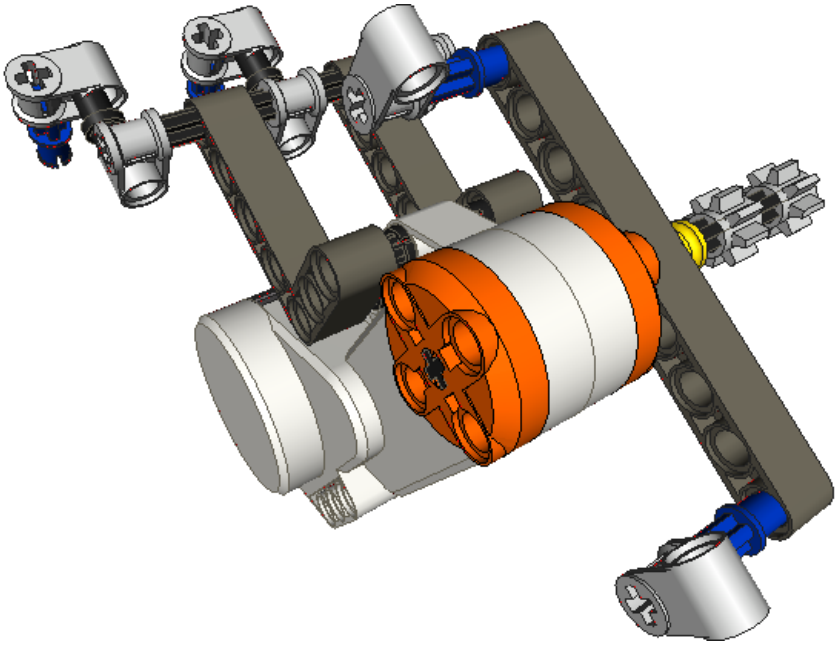
1 x yellow fastener

1 x (1x6) rod

1 x (1x8) rod 

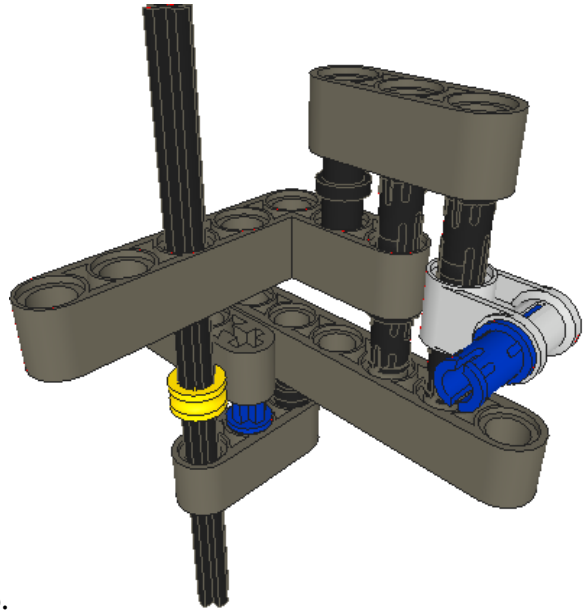
1 x NXT servo motor 

14. 

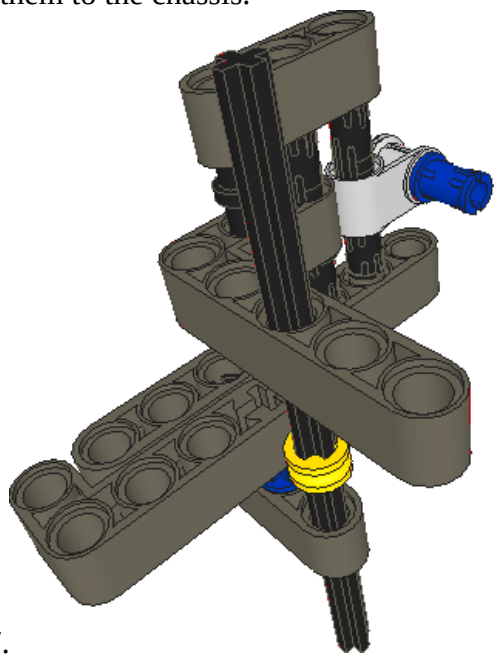
15. 

4.6. Steering

These brackets will support the wheels and sensors, attaching them to the chassis.



16.



17.

Build one and then build a mirrored opposite. For both you will need:

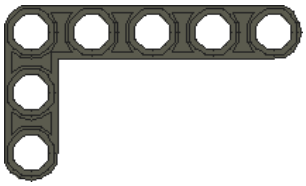
4 x black single connectors

4 x black double connectors

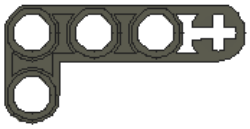
4 x (1x3) bars

2 x (1x7) bars

2 x (3x5) angled bars



2 x (2x4) angled bars

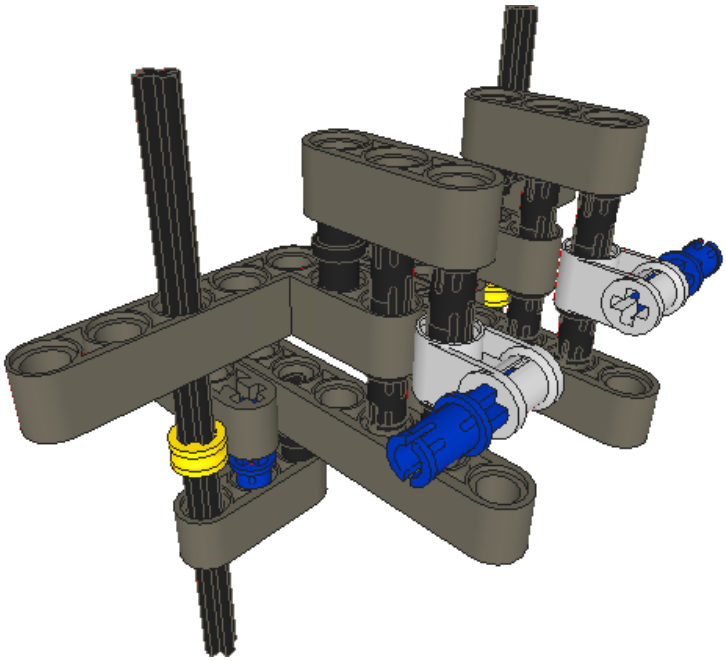


4 x blue connectors

2 x yellow fasteners

2 x light grey angled joints

2 x (1x10) rods



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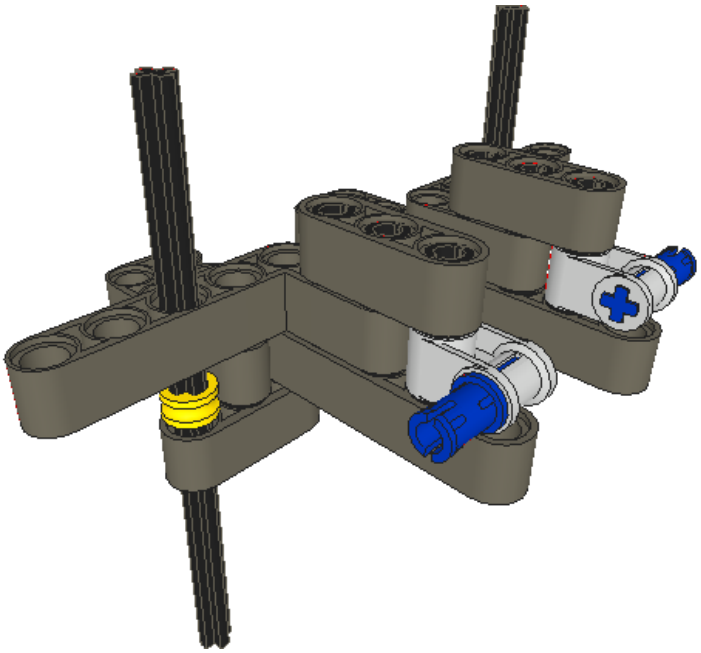
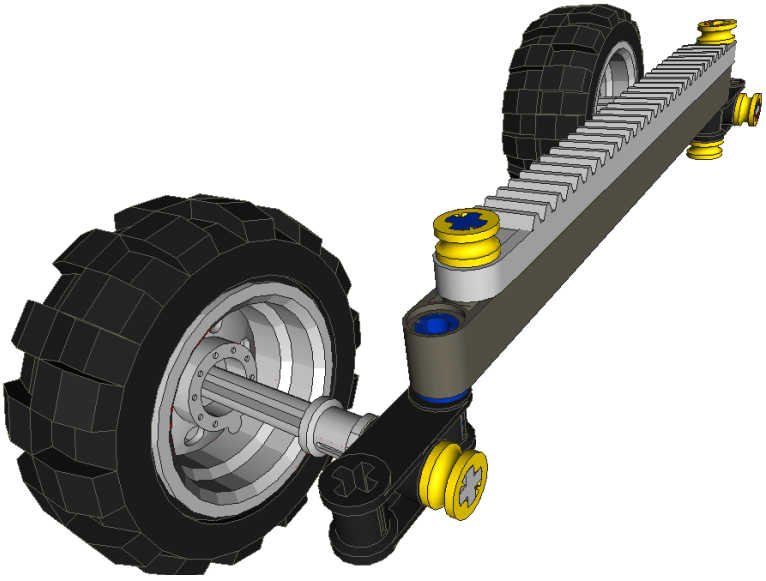


19.

4.7. Wheels

20.



21.

Assemble the wheels as shown taking note that the connection to each wheel to the cross arm is different. For this you will need:

2 x (1x5) rods

1 x (1x4) rod

5 x yellow fasteners

2 x grey fasteners

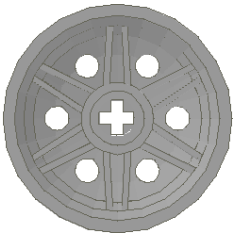
2 x blue connectors

2 x black angled joints

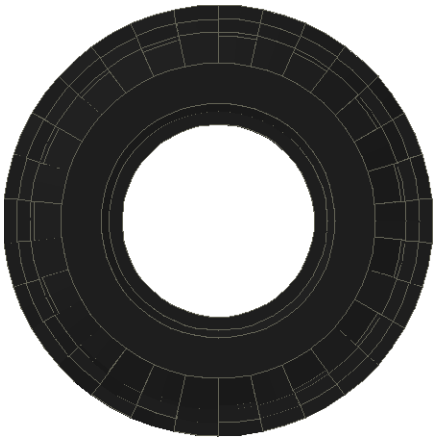
1 x (1x15) bar

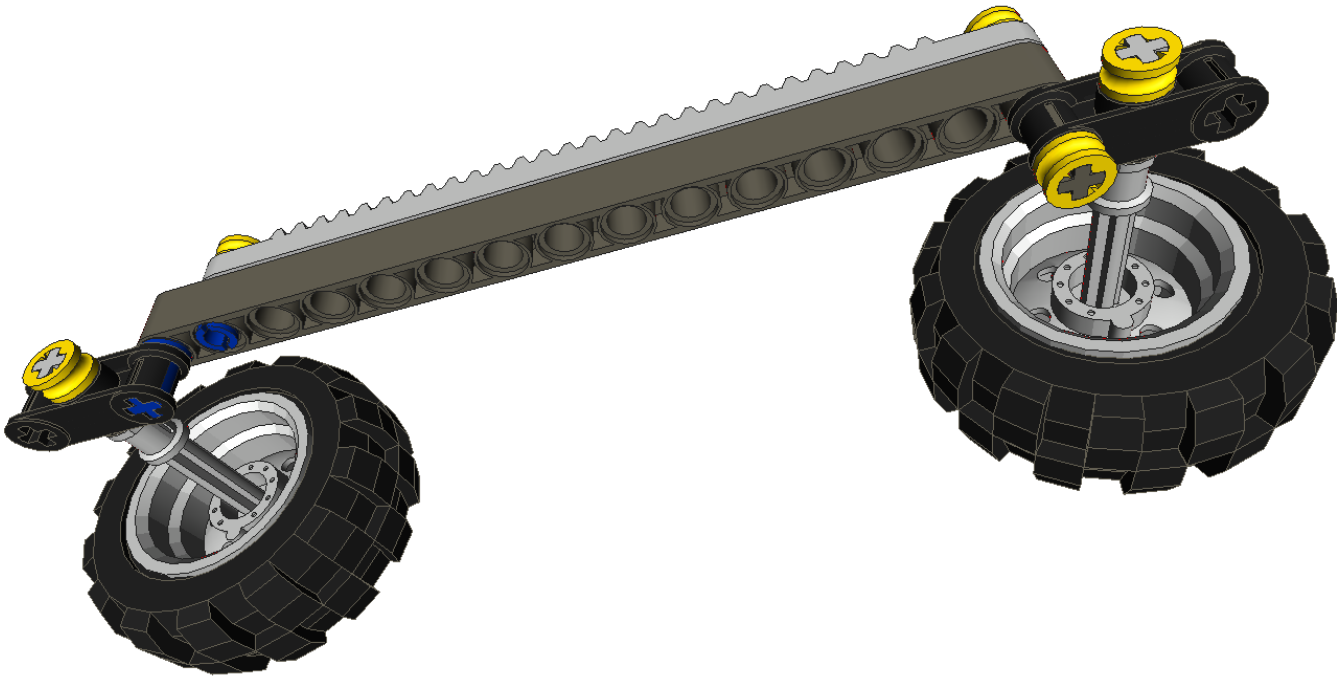
1 x rack

2 x large wheels



2 x large tyres



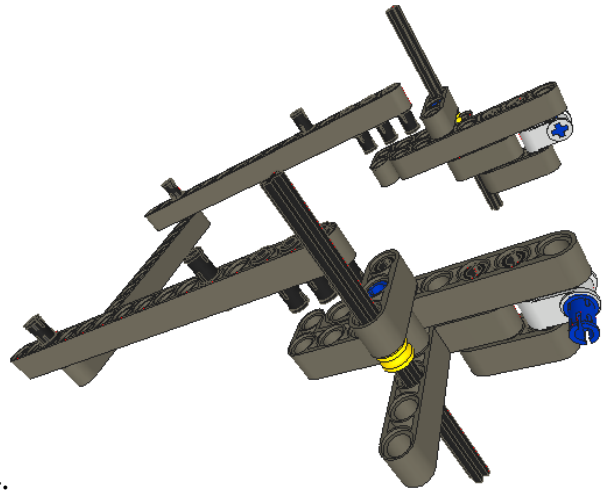


22.

4.8. Assembly

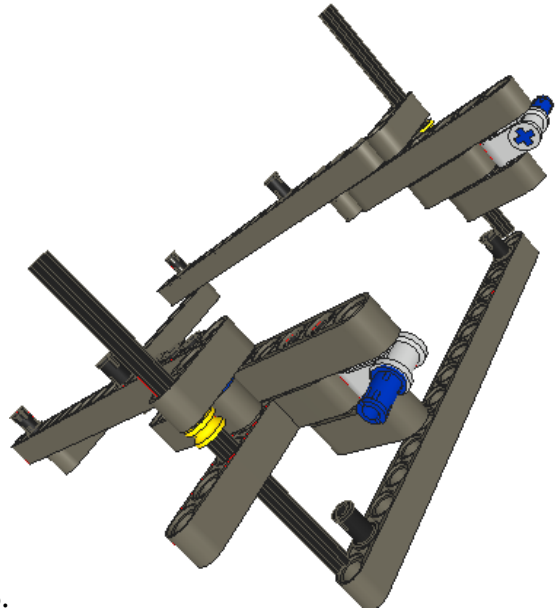
Take the chassis assembled earlier and attach the steering supports as shown, ensuring that they are the correct way round.

23.

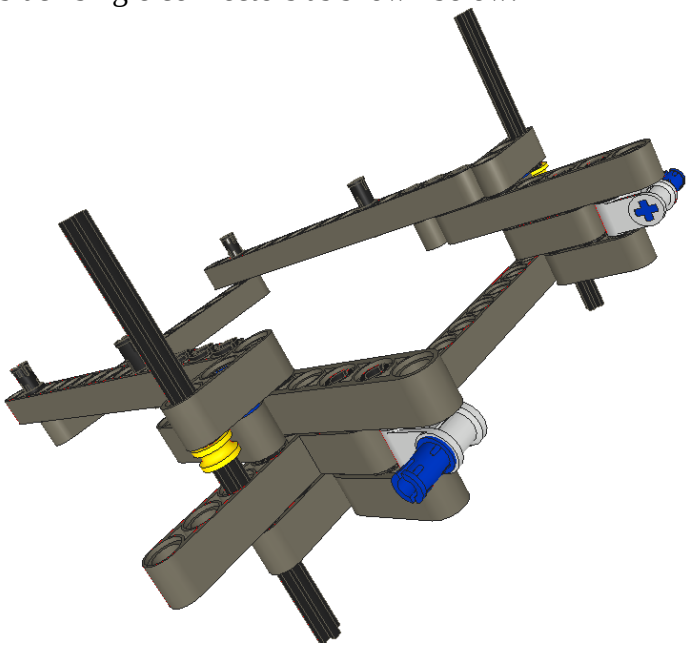


24.

Attach the securing (1x15) bar from earlier using two black single connectors as shown below.

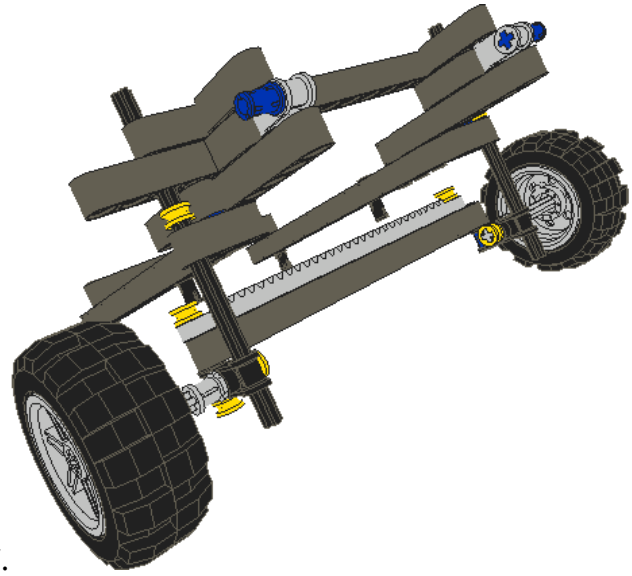


25.



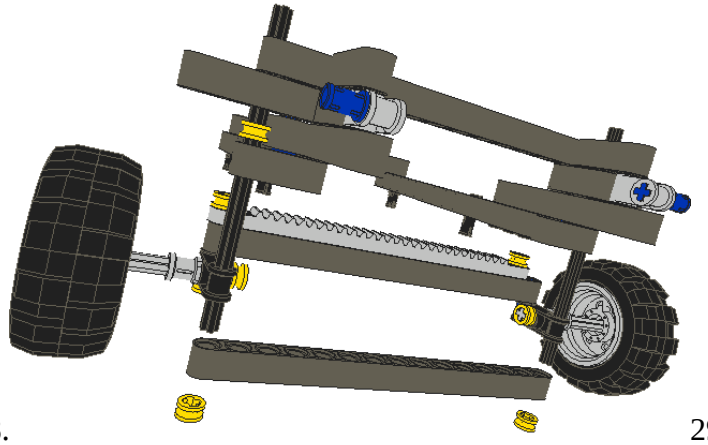
26.

<u>Turn over the chassis</u> and attach the wheels and cross arm constructed earlier.

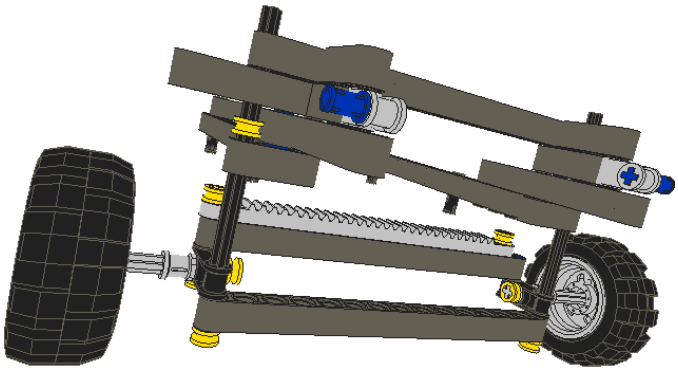


27.

Stabilise the wheels using a (1x15) bar as illustrated below.

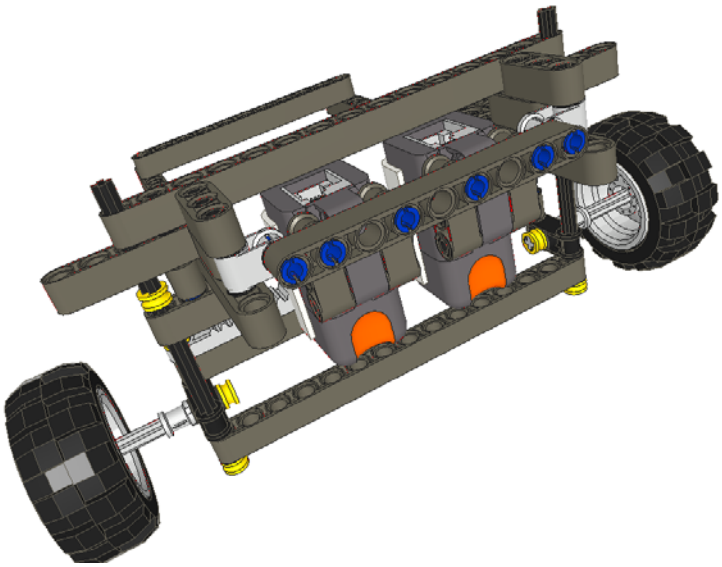


28.

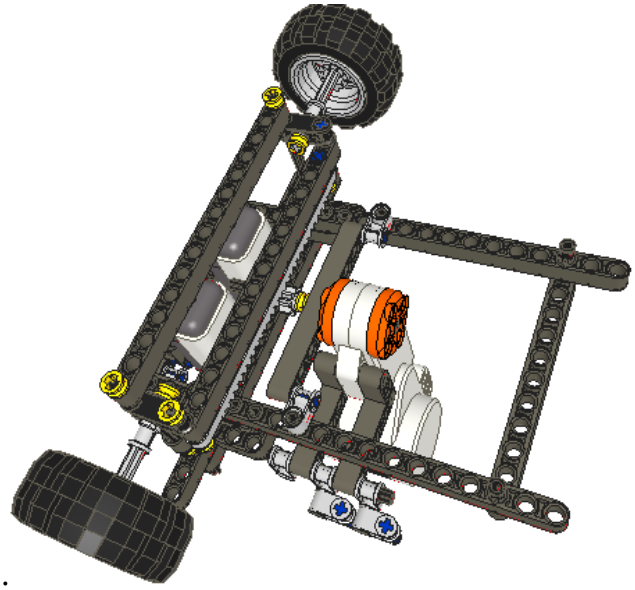


29.

Attach the sensors using the blue connectors on the chassis as shown in 30 below.

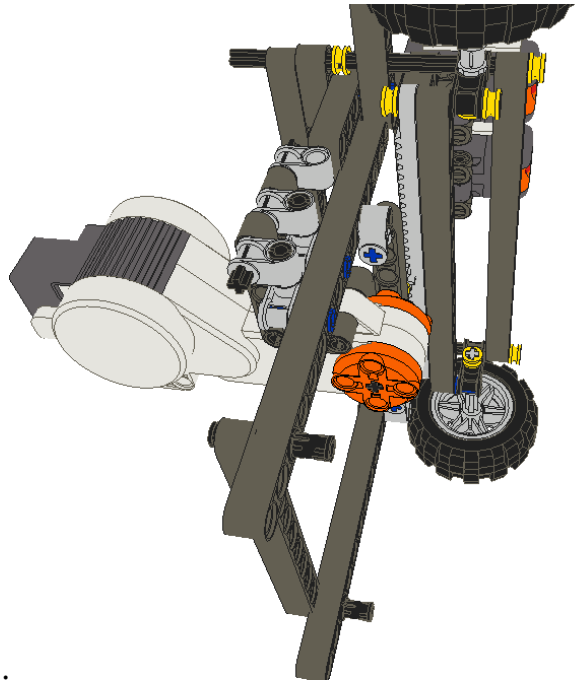


30.

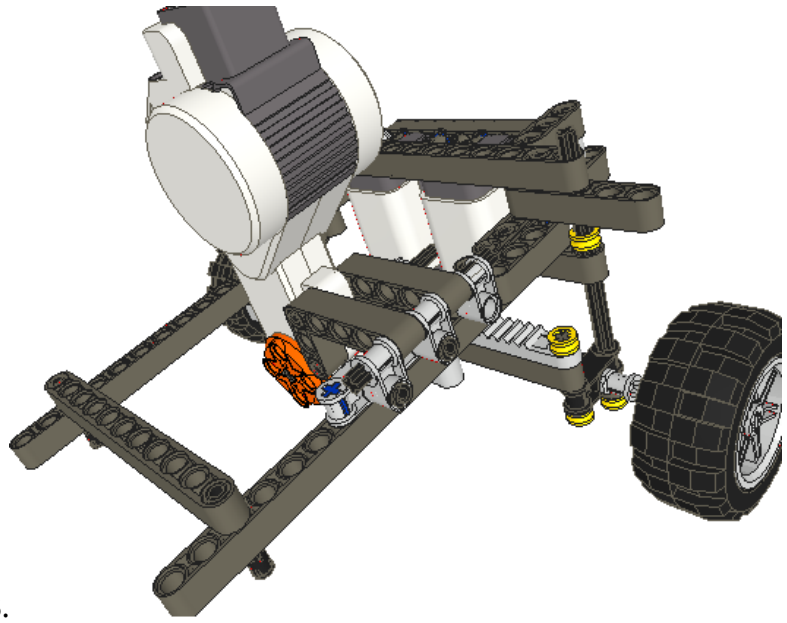


31.

Place the steer motor in the centre of the chassis and attach to either side using the pre-mounted connectors as demonstrated in 31.



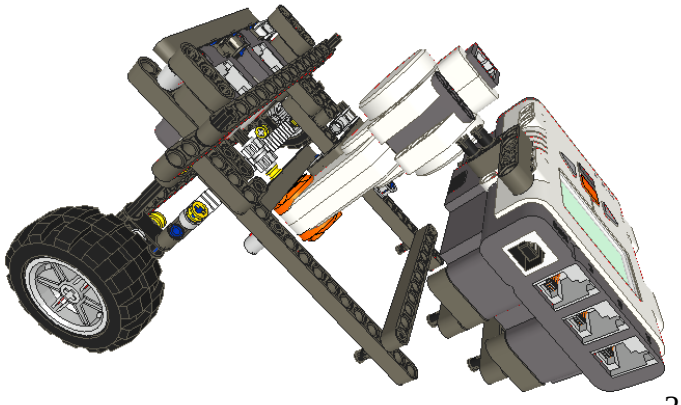
32.



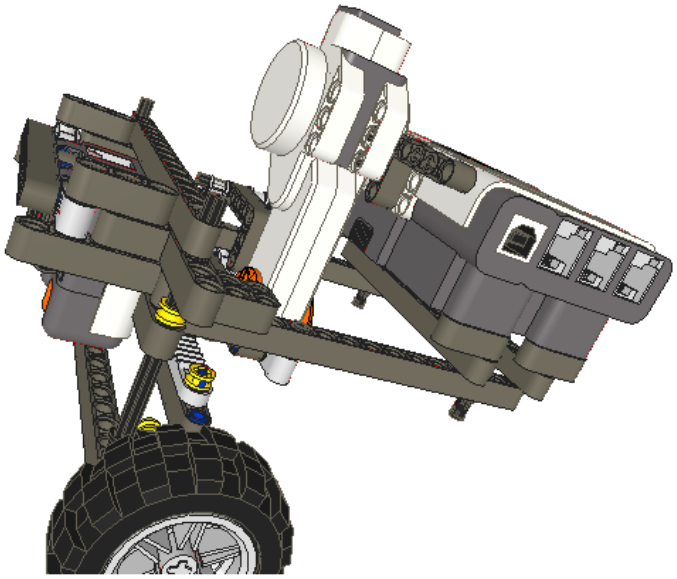
33.

Swivel the connectors on the steer motor to secure it to the chassis as shown above.

Orientate the NXT block to connect with both the steer servo motor and the chassis as shown below.

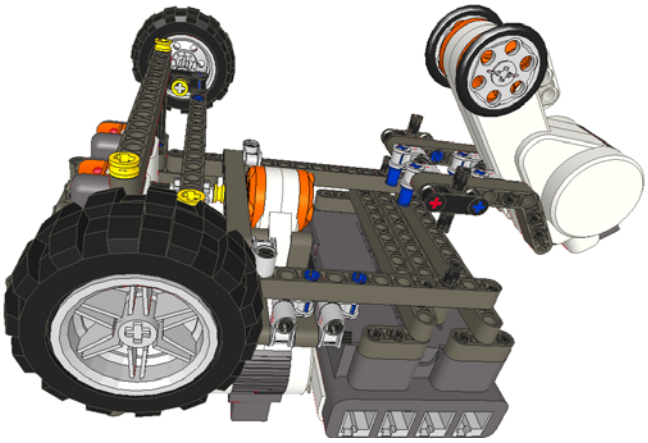


34.

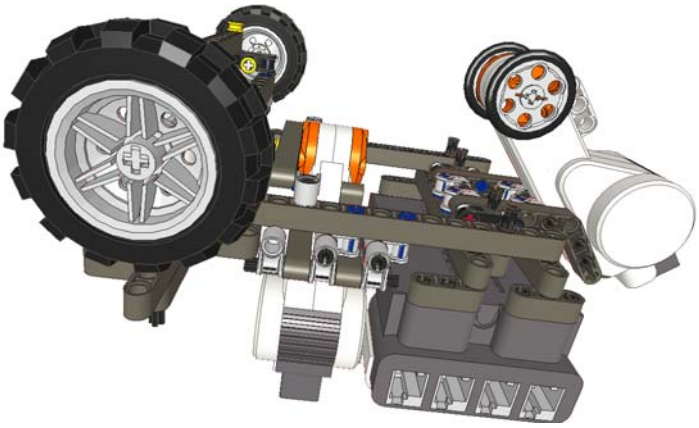


35.

Position the drive motor underneath the NXT brick ensuring it is central to the chassis and attach.

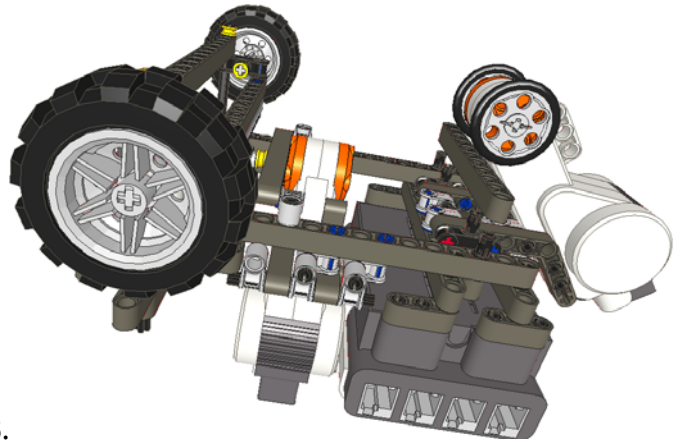


36.

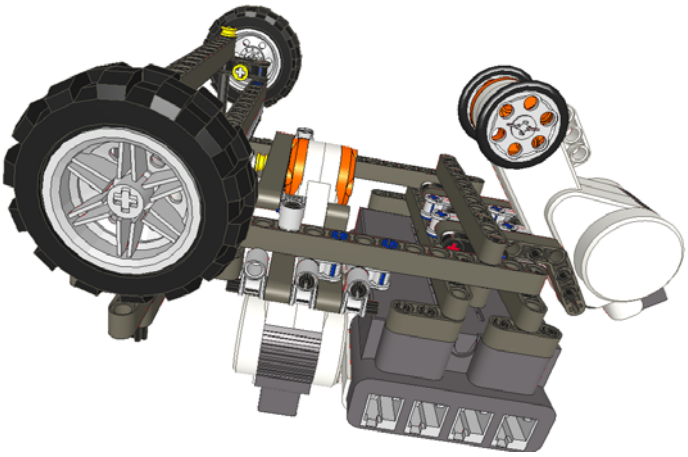


37.

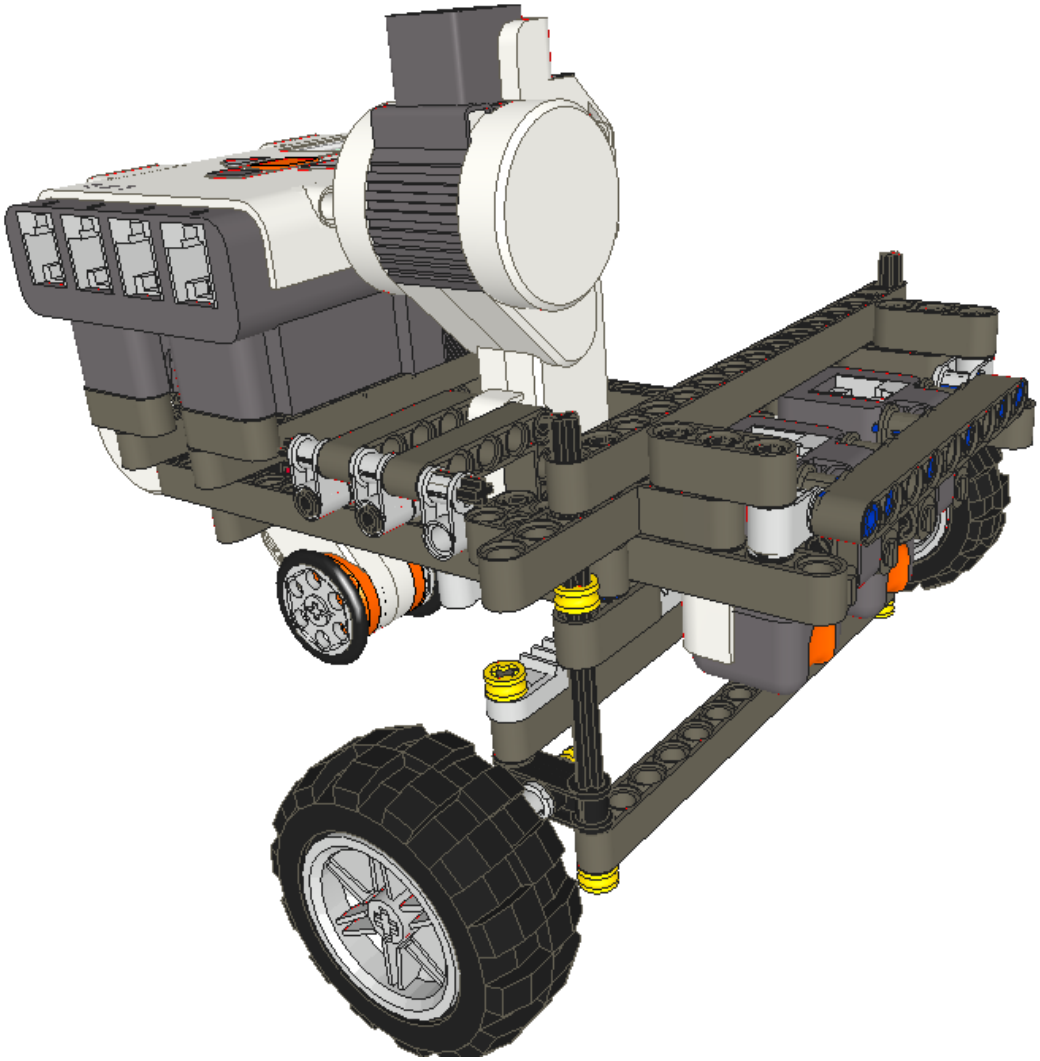
Attach a securing arm (1x11) bar as illustrated below



38.



39.



40.

Now all that remains is the cables, be carful not to place a cable near to moving parts!

1. Connect the driving servo to port A on the NXT brick.
2. Connect the steering servo to port B on the NXT brick.
3. Looking from the back of the car to the front, connect the left sensor to port 4.
4. Connect the right sensor to port 3.

~~The construction process is now complete,~~

5. ~~Place the Cart at the start of the line, with the line exactly between the two sensors.~~
6. ~~Press the orange button on top of the NXT to turn it on.~~
7. ~~Start the LabView VI "Line Follower USB.vi" or "Line Follower BT.vi" depending on the connection choice. You may be required to press the orange button on the NXT brick to pair the device with the computer when using Bluetooth connectivity.~~