

Design Document

- **Mechanical mounting**

The whole mechanical system includes two parts: Scooper and Loader as shown in Fig. 1 and Fig. 2 respectively.

1. Scooper

Top view of Scooper

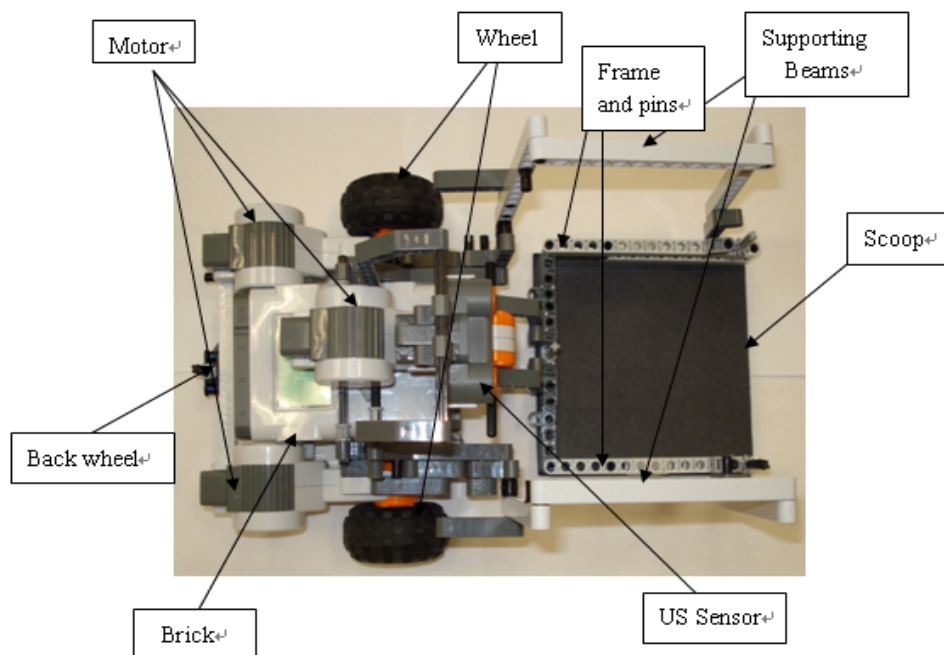


Fig. 1 Scooper

- Main Function

The main function of scooper is to load balls from Loader shown in Fig. 2, and unload them into a bowl-shaped plastic container.

- Main components

- a. One Brick
- b. Three motors- One for manipulating front scoop and two for driving the robot
- c. One Ultrasonic sensor
- d. One scoop with the shape as shown
- e. Two wheels and a Back wheel same designed in LEGO NXT brochure

- Rationale for mechanical design

Scoop: This is specified by clients or end users. Its main function is to load balls from Loader shown in Fig. 2 and Unload balls to a bowl-shaped plastic container. It could be lifted up and down by appropriate motor motion attached to it as shown in Fig. 1, i.e. the center

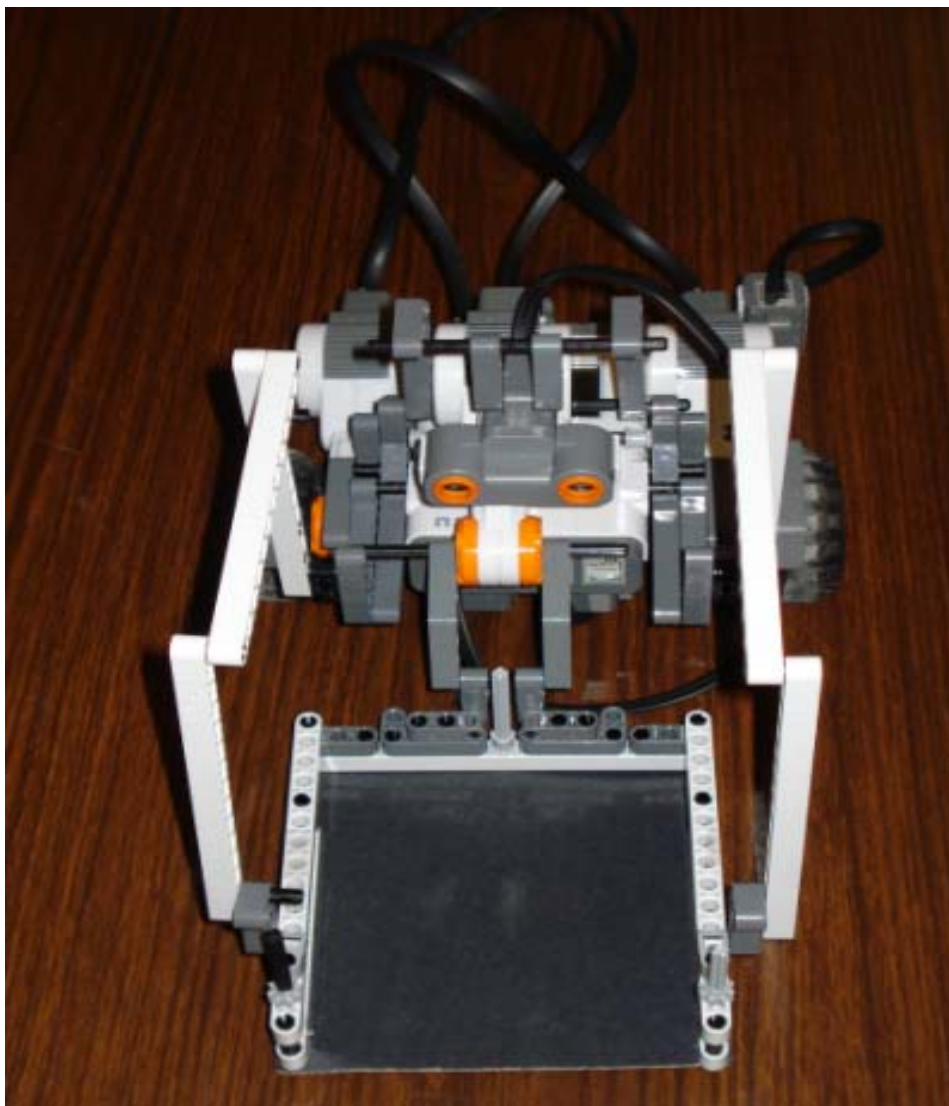
motor. While it is lowered down to the ground level, the scoop is tilted a bit toward to the motor in order to prevent the ball from rolling out of the scoop. After the ball is loaded, the scoop is lifted up to a certain level, a bit above the rim of the bowl-shaped plastic container, i.e. around 2 cm, and tilted toward to the plastic bowl by appropriate motor motion for the ball to roll into it.

US sensor: The main function of this US sensor is to detect obstacles in front of it and try to avoid it. One might have noticed that the sensor is mounted above a ball height, that is because the scoop is not responsible for searching for balls and in order not to be confused for a ball as an obstacle, i.e. just ignore balls while navigating to destination

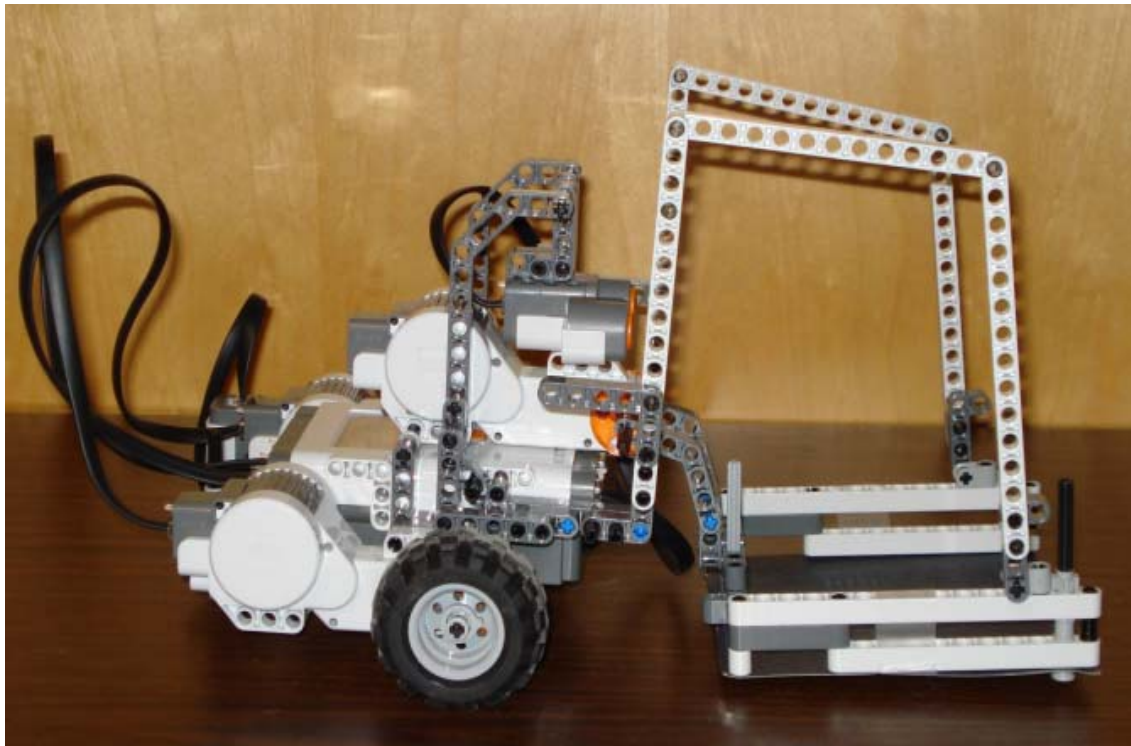
Brick: The Brick is mounted this way only because it would balance the weight of the robot in order for it to travel more smoothly.

Note: The scoop could be mounted in a different way as long as the basic structure specified by the client does not change.

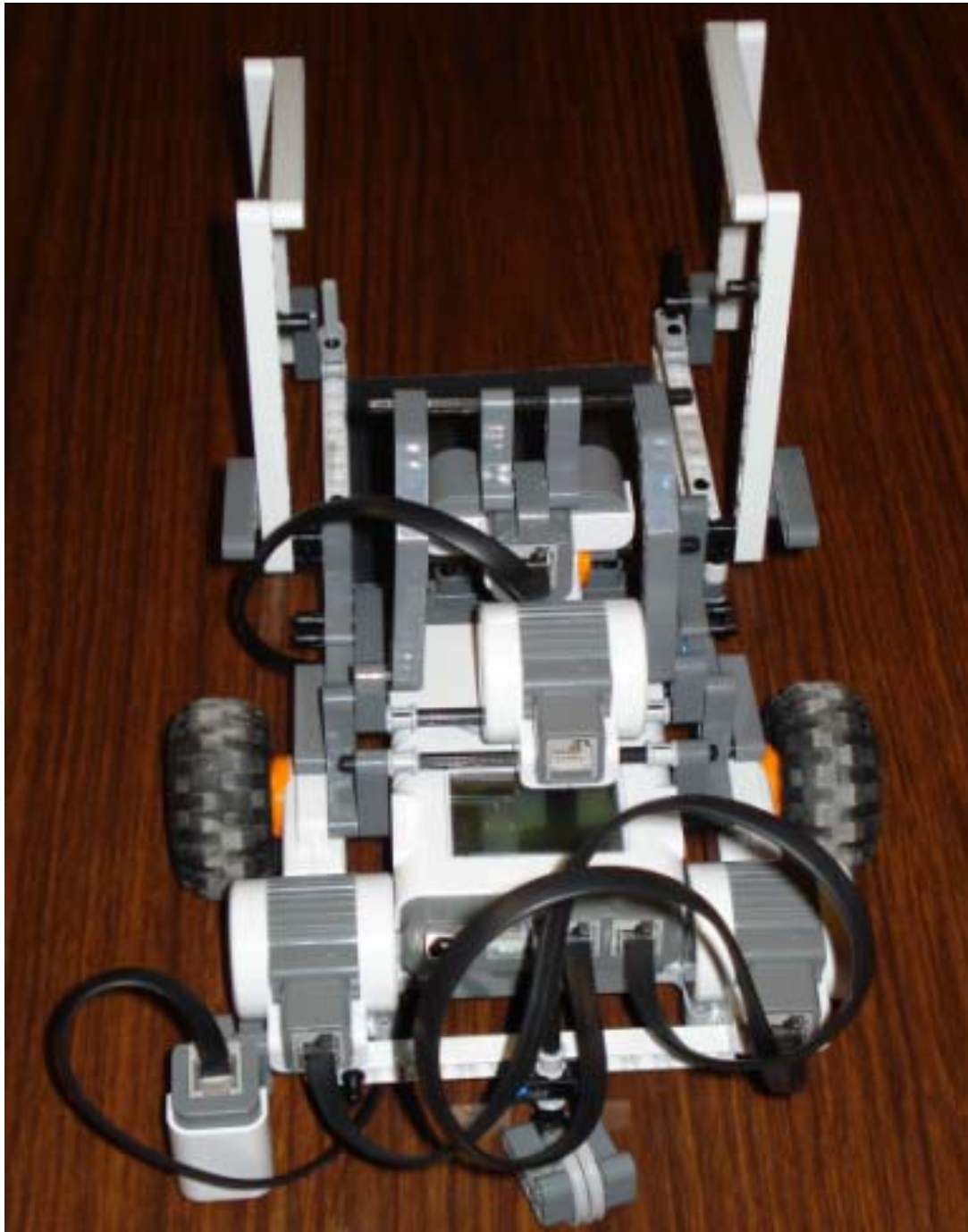
Front view of Scooper



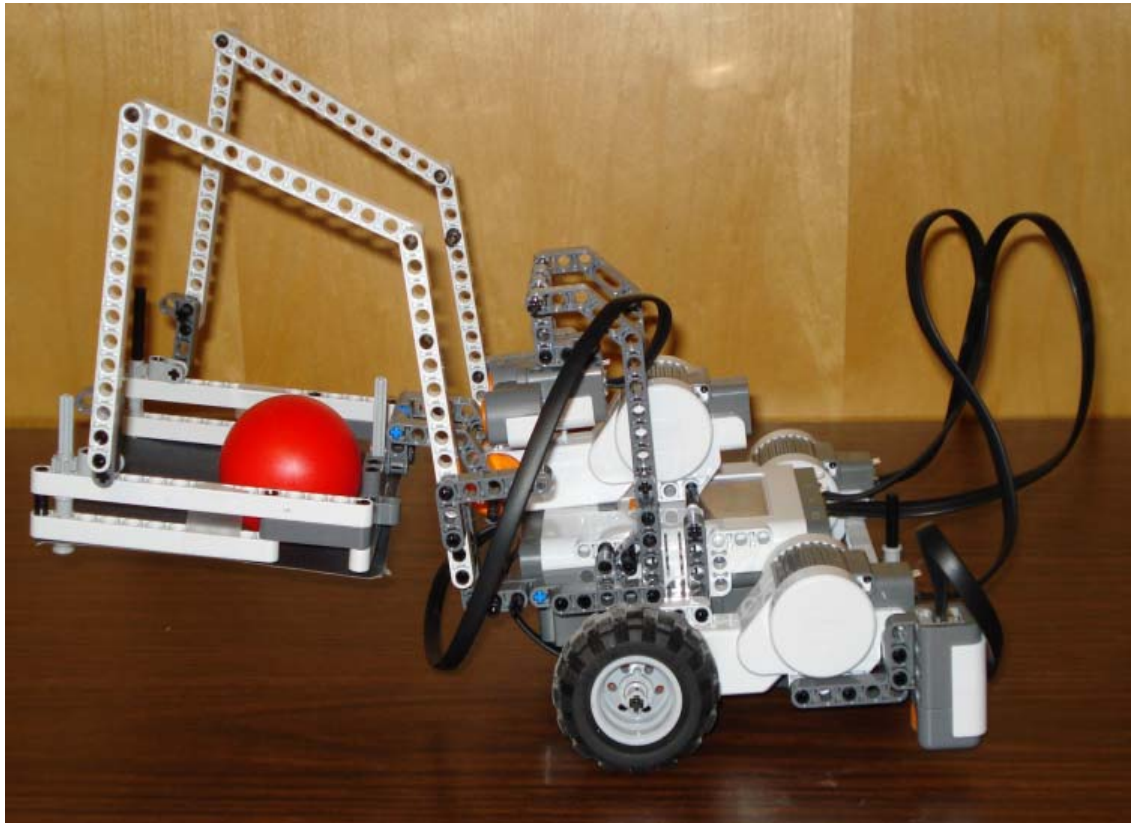
Side View of Scooper



Back View of Scooper



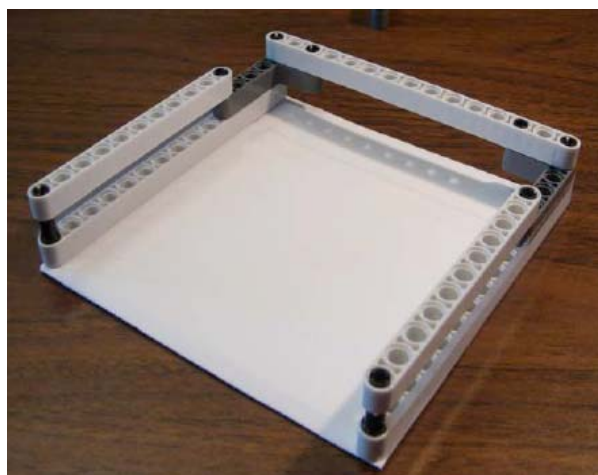
Scooper with Ball



- Detailed assembling instruction for scoop

Please refer to the following drawings for details.

- Assembly drawing

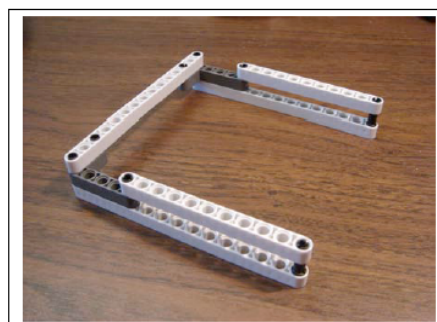
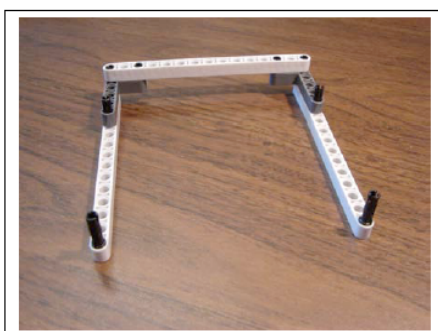
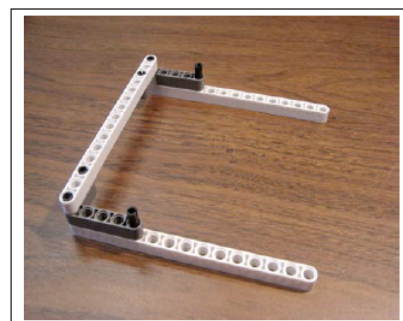
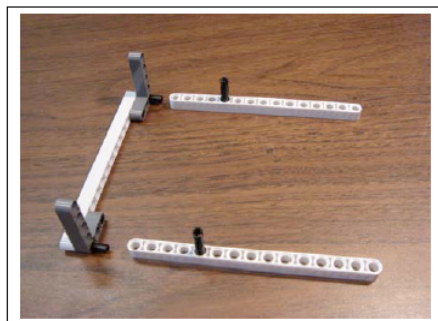
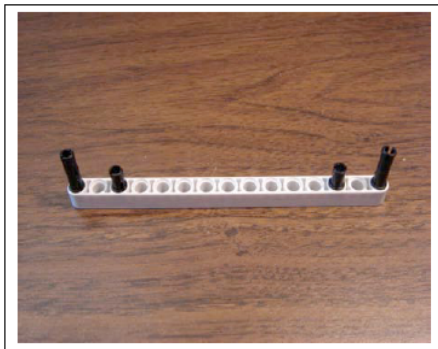


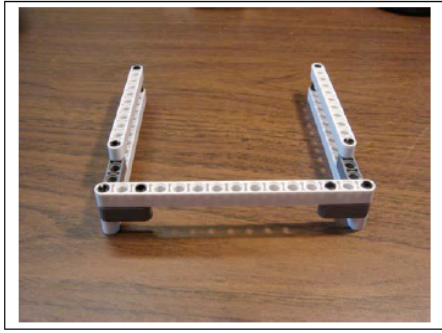
Please refer to the following drawings for details.

- **Parts list**

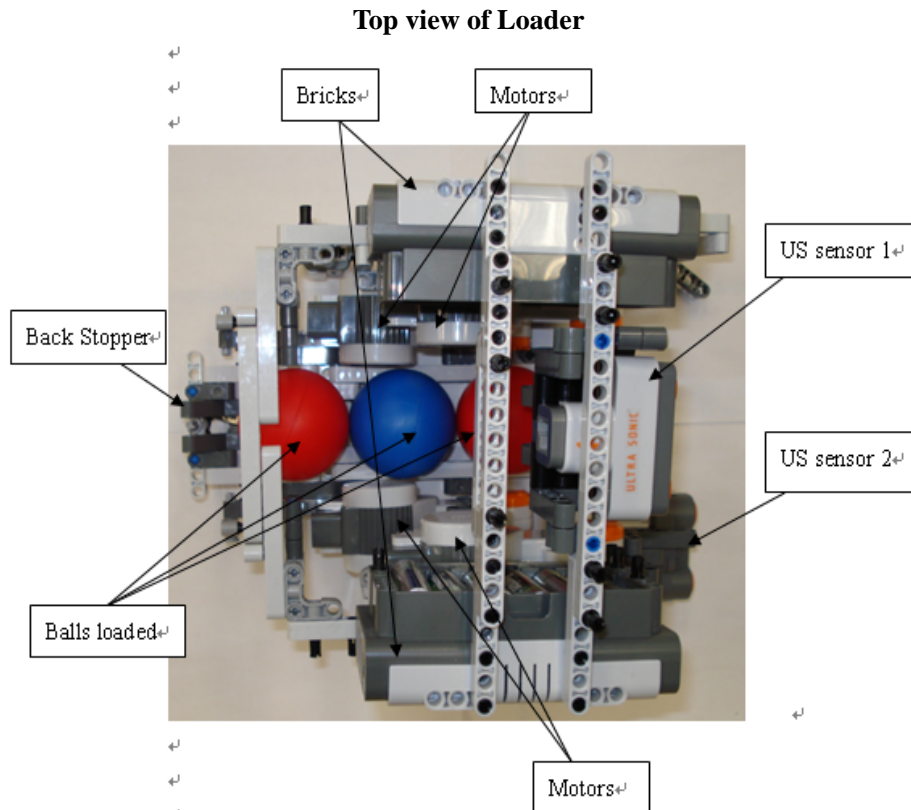


- **Assembly steps**





2. Loader



- Main Function

Loader is as shown in Fig. 2. The main function of loader is to search balls in a 4X4 maze with randomly oriented cinder blocks inside, to collect balls after they have been identified, to load balls into the slide rails as shown, to avoid obstacles while navigating and to instruct scooper to a specified location.

- Main components

- a. Two Bricks
- b. Four motors- two on each side respectively
- c. Two Ultrasonic sensors- one for detecting obstacles and one for detecting/identifying balls
- d. Two light sensors- one for detecting balls loaded and one for tracking black grid lines on the ground
- e. Two wheels and a Back wheel same designed in LEGO NXT brochure
- f. A Y-shape manipulator specified by end users

- Rationale for mechanical design

Two Bricks: From point of view of functionality, the complexity of tasks fulfilled by the loader requires 2 Bricks. One is negotiating navigation, ball detection/identification,

obstacle avoidance and movement control. And one is for synchronizing loading function via Bluetooth. From the point of mechanical view, originally the two Bricks were mounted in the back, the main drawback is obvious that almost all the weight was added to the back part of the robot and thus causing the movement of robot is not balanced. By mounting the two Bricks on the sides, the above problems are eliminated.

Four motors: Two motors are for driving the robot. One motor is for manipulating the Y-shape and the other motor for moving the ball manipulator.

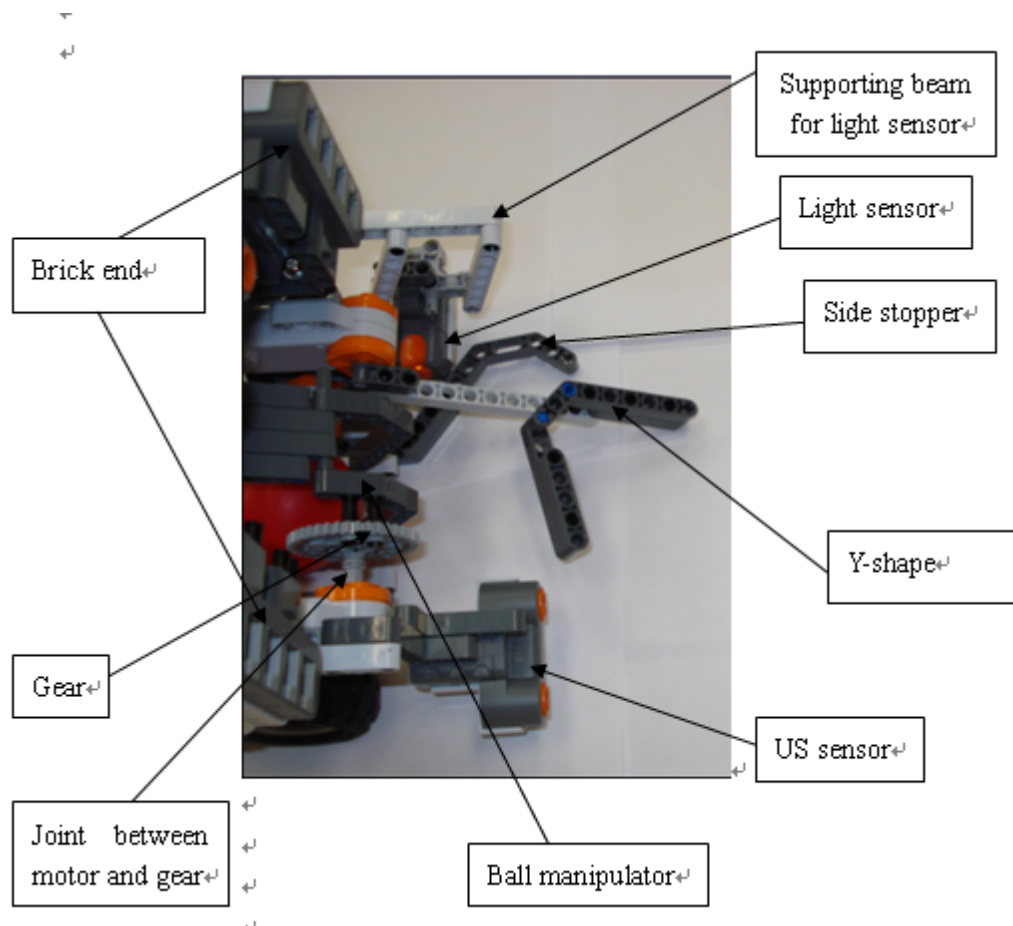
Two Ultrasonic sensors: One is for detecting obstacles, i.e. cinder blocks and walls, bowls other than balls. The other one is for detecting balls only. The upper sensor is mounted higher above a ball height only because it would ignore balls while both balls and obstacles are in front of it. If the readings of these two sensors are different, there must be a ball. Otherwise, if the two readings are the same, there must be an obstacle in front of it. In doing this way, the robot will detect balls and obstacles efficiently.

Two Light sensors: One for detecting the ball while the ball is actually loaded or just in front of the ball manipulator. The other is for error correction, tracking the black lines on the ground while navigating.

Y-shape: It is specified by client and used for unloading balls to the Scooper

- Detailed assembling instruction for Loader

Side view of Loader front end

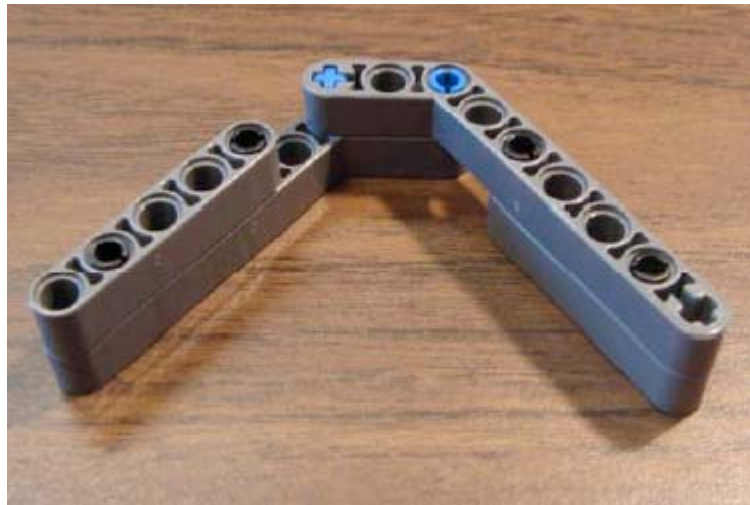


- **Y-Shape:** Specified by client and is attached to the upper motor by a bar. It could move up and down via appropriate motor motion. While navigating, it will lifted up for easy movement.
- **Ball manipulator:** Attached to the lower motor via a gear. It could move up and down by appropriate motor motion to allow balls to go into or come out of the slide rails between the two Bricks. While navigating, it is positioned as shown.
- **Light sensor:** Attached underneath the upper motor for detecting balls is loaded/unloaded
- **US sensor:** Attached on the lower motor and very close to the ground level for detecting balls in front of the robot
- **Side stopper:** Any bar tied to the robot to make sure balls loaded/unloaded to roll within a certain range

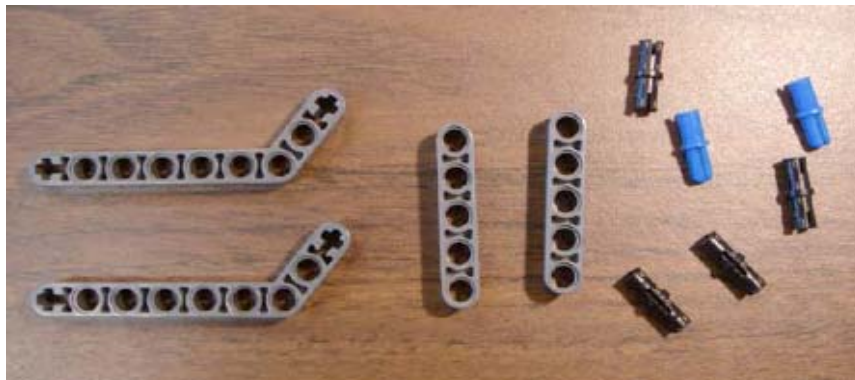
Note: The above assembly drawing is subject to changes as long as the main function does not change.

Y-Shape

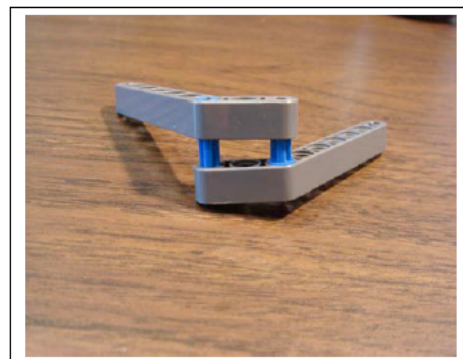
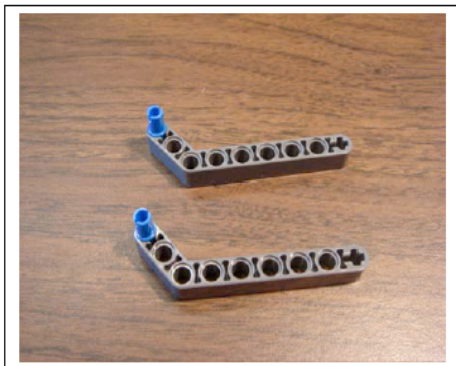
- **Assembly drawing**

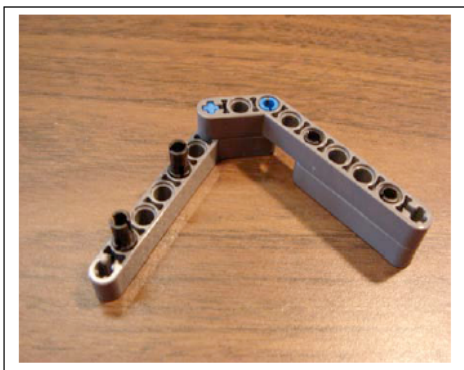
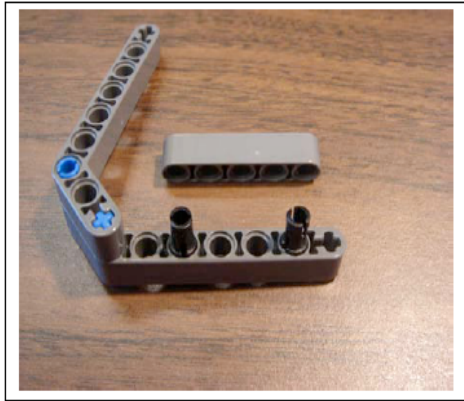


- **Parts list**

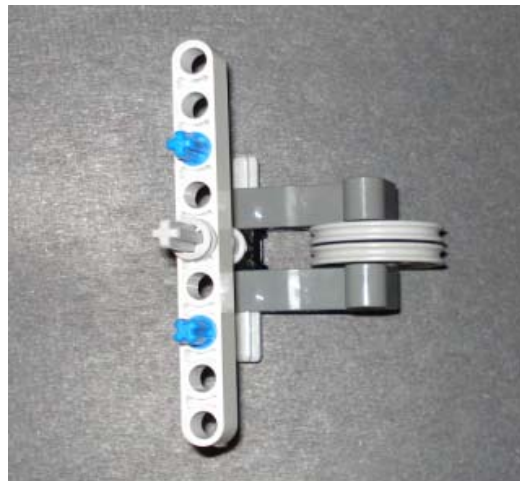


- **Assembly steps**

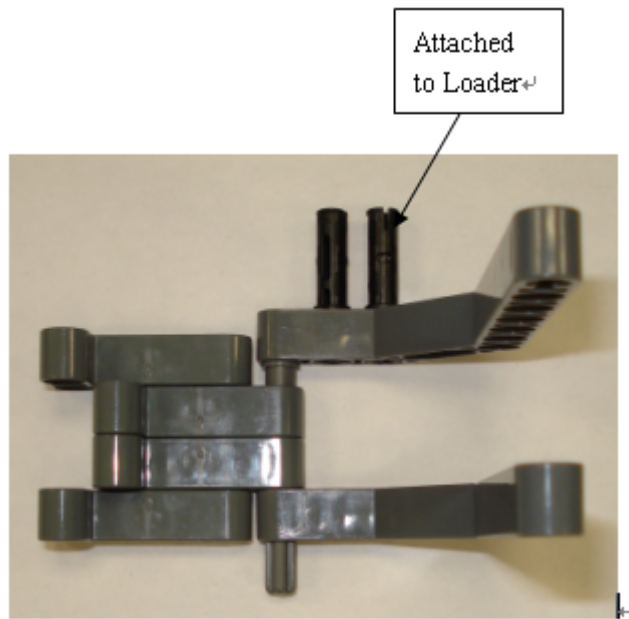




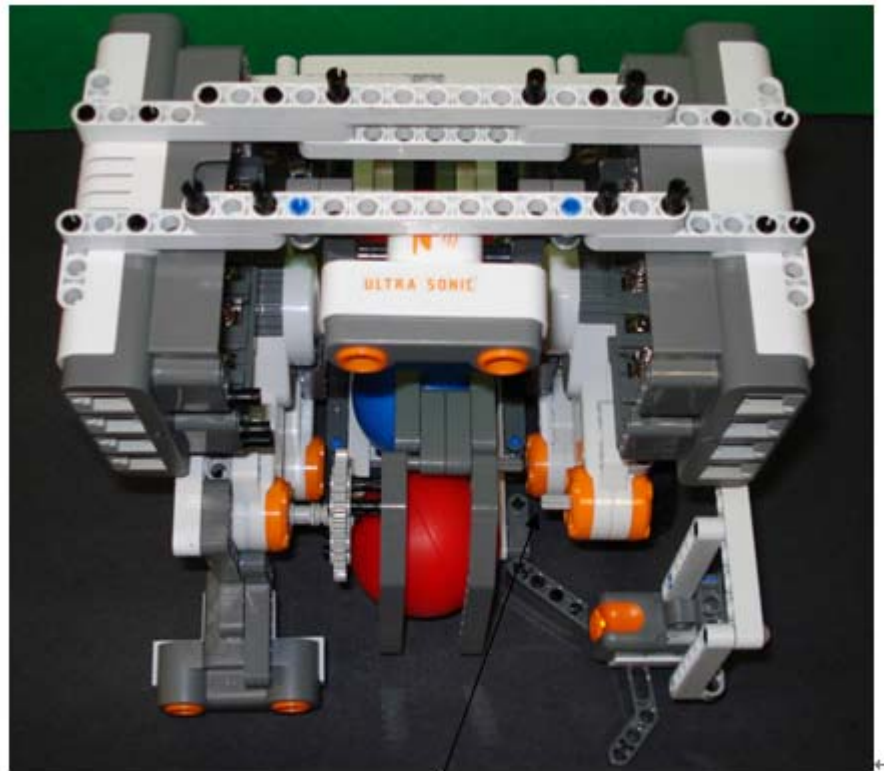
Back wheel



Ball manipulator

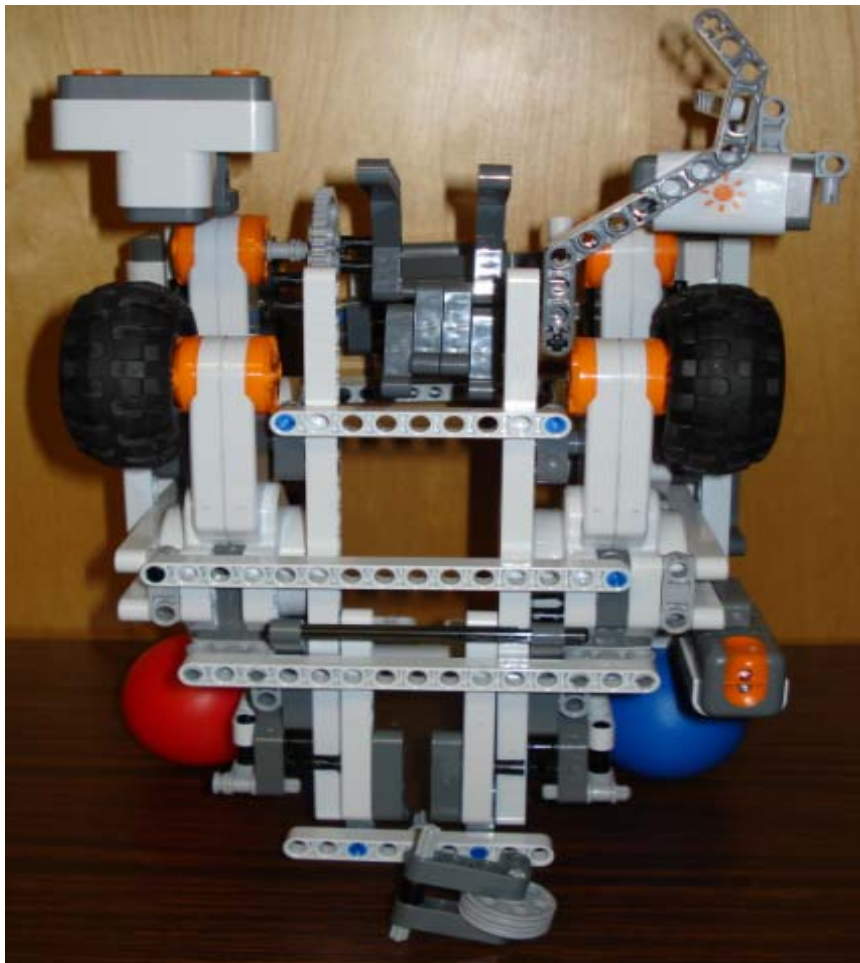


Loader without ball manipulator

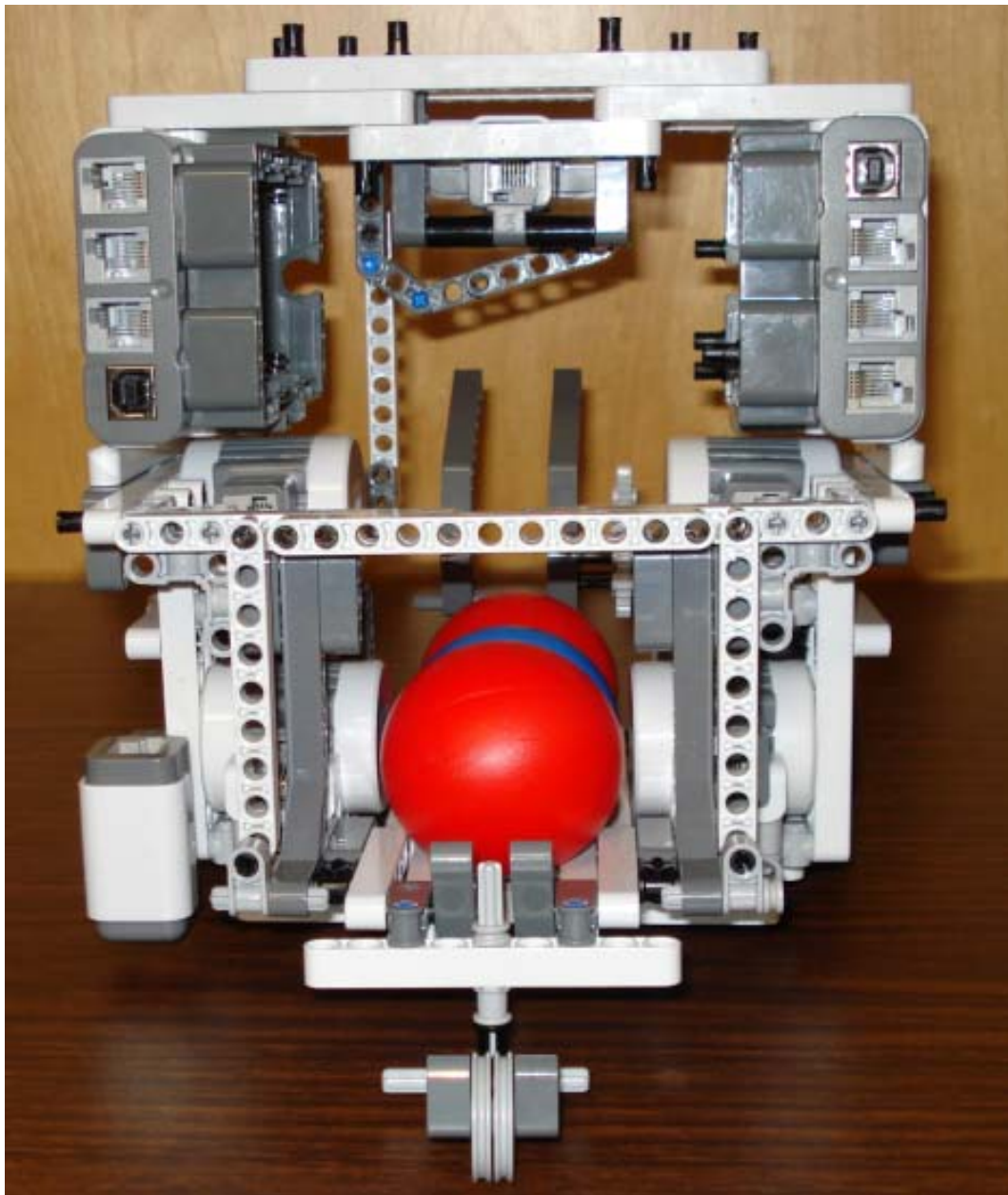


Ball-manipulator
attached to here

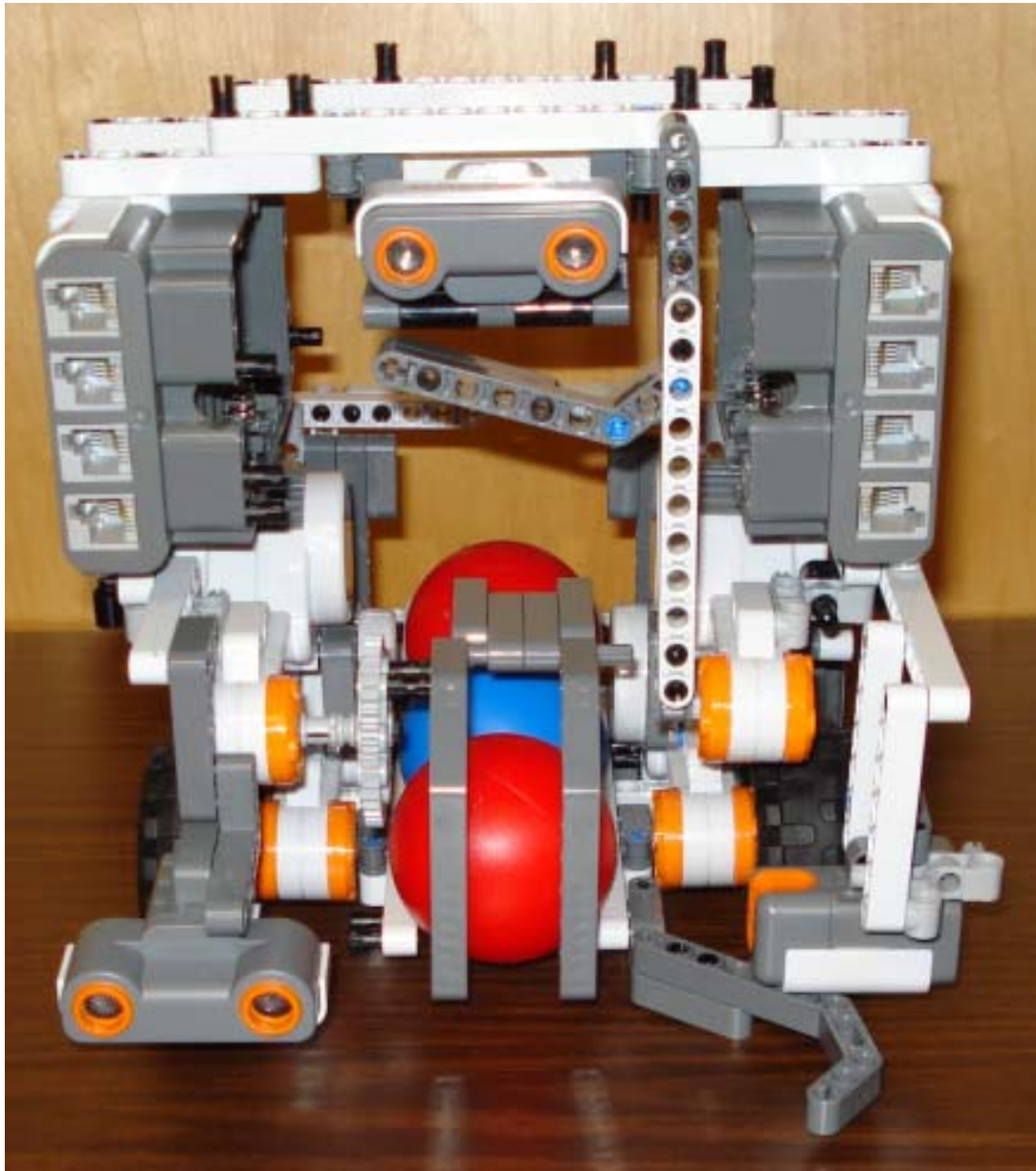
Bottom view of Loader



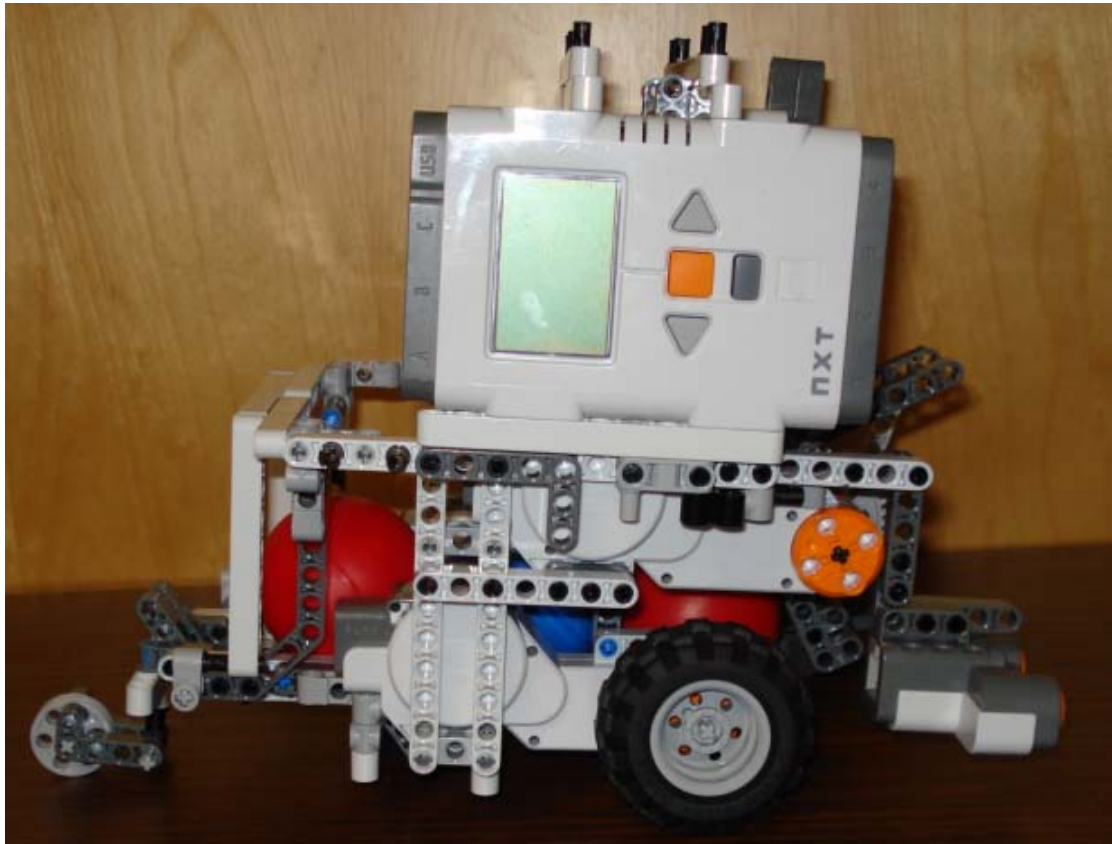
Back view of loader



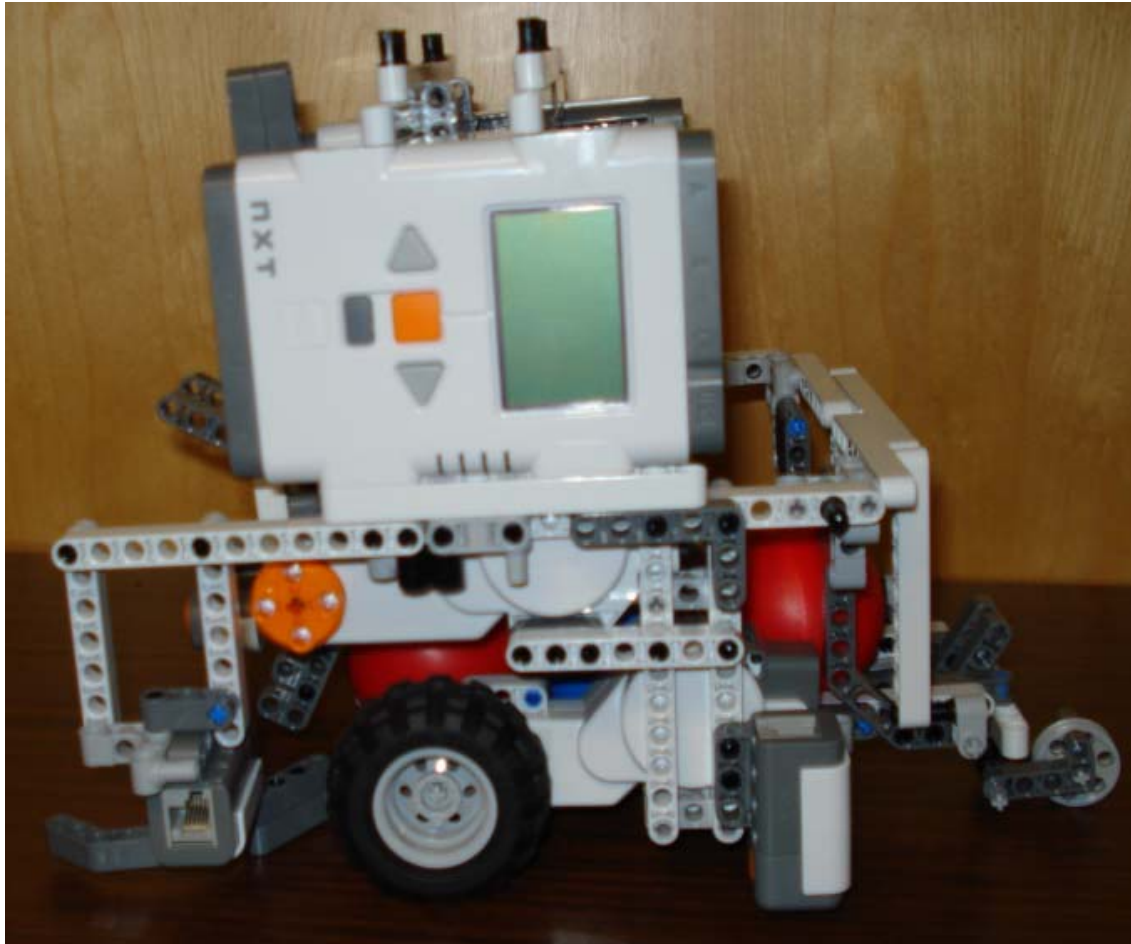
Front view of Loader



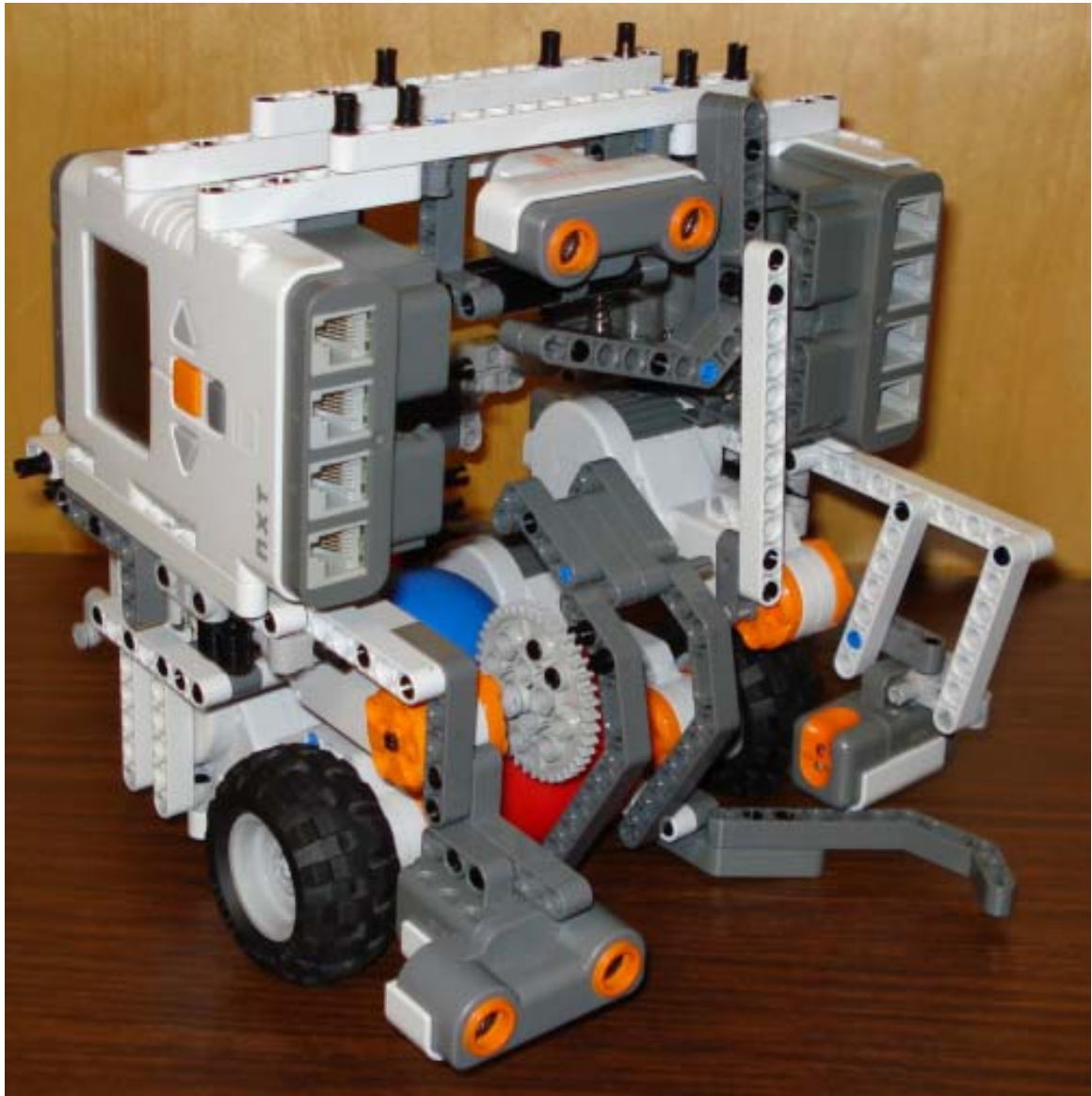
Side view 1 of loader



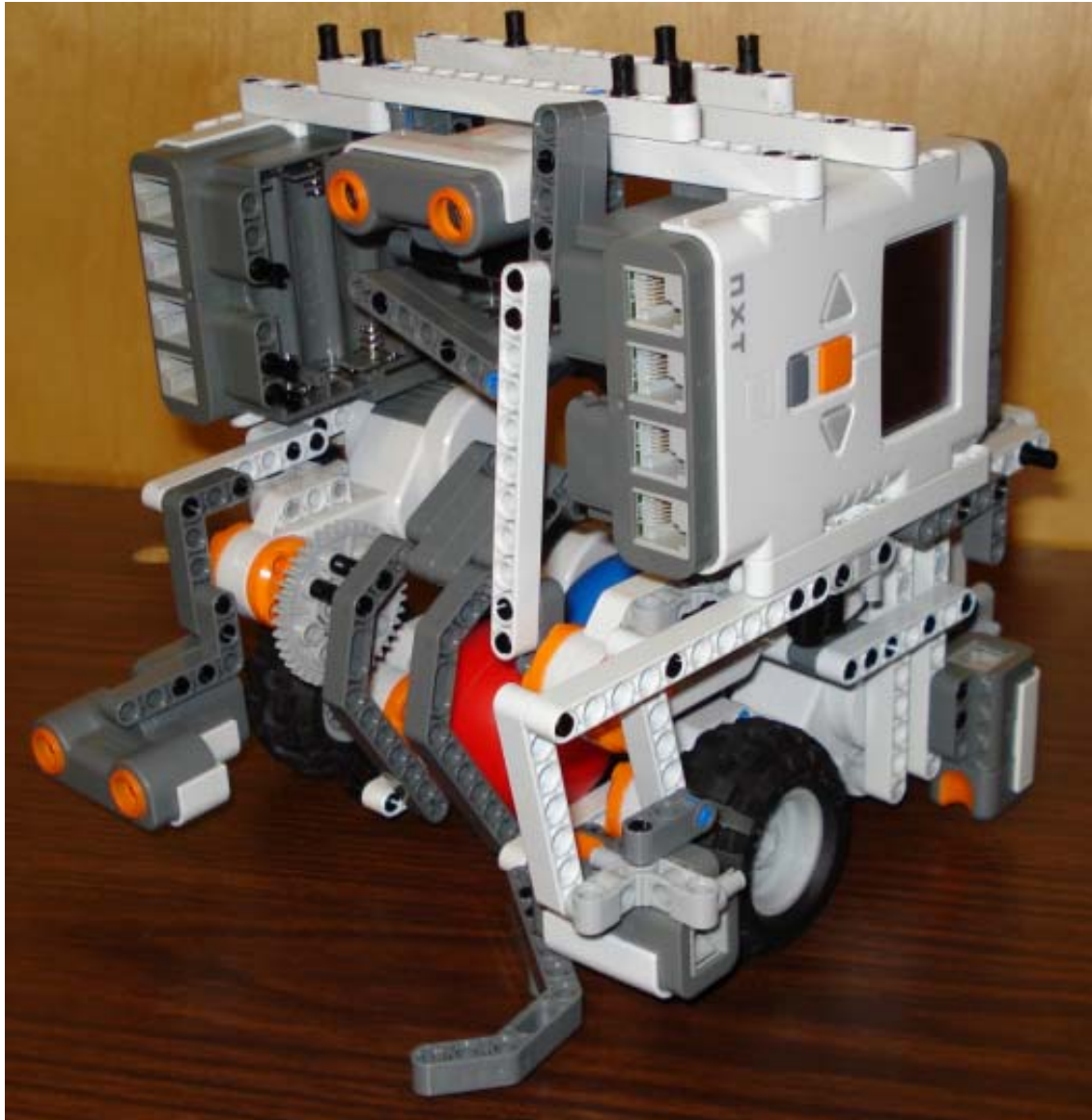
Side view 2 of loader



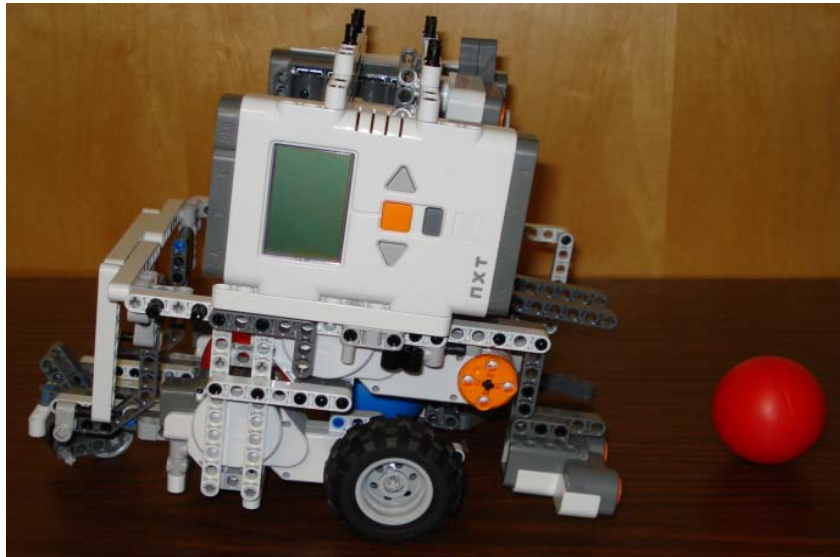
45 Degree view of Loader



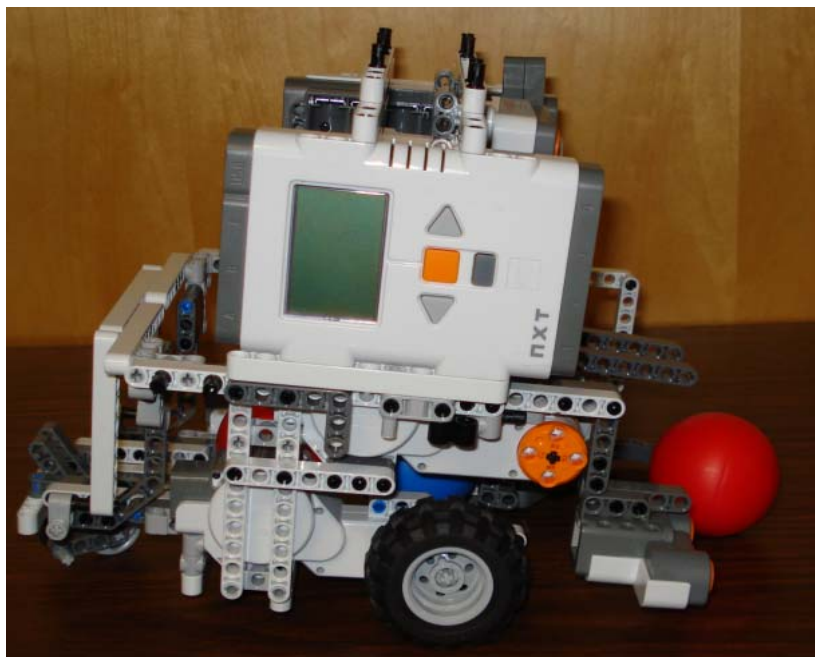
135 Degree view of Loader



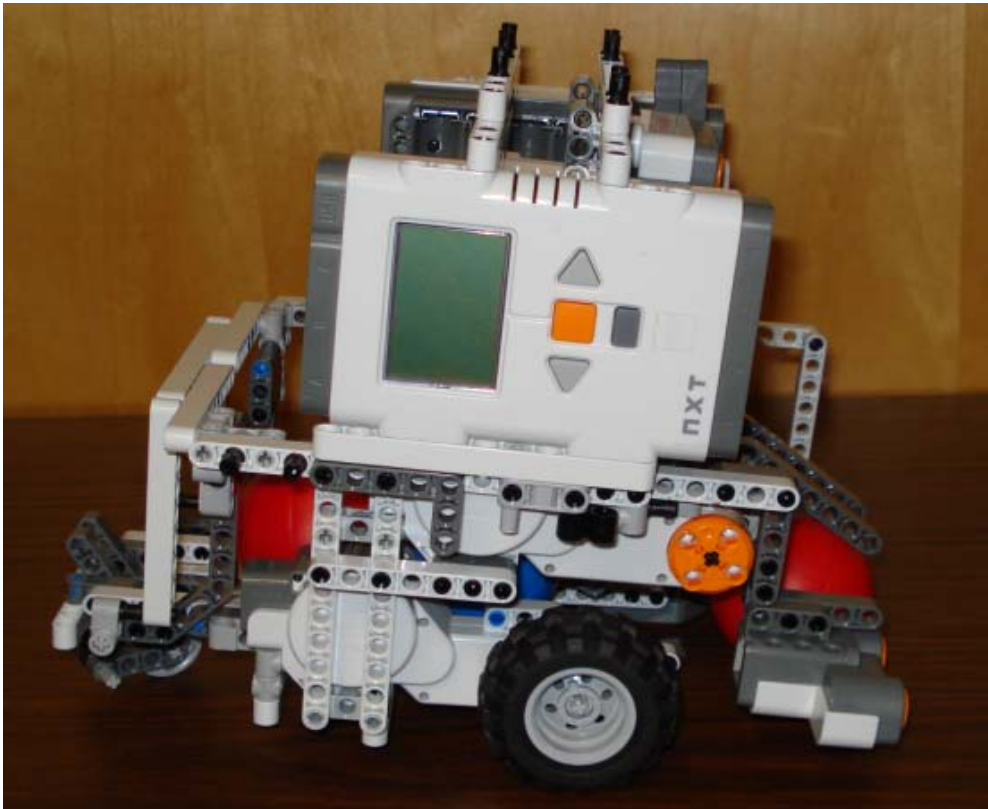
Loader with Ball 1



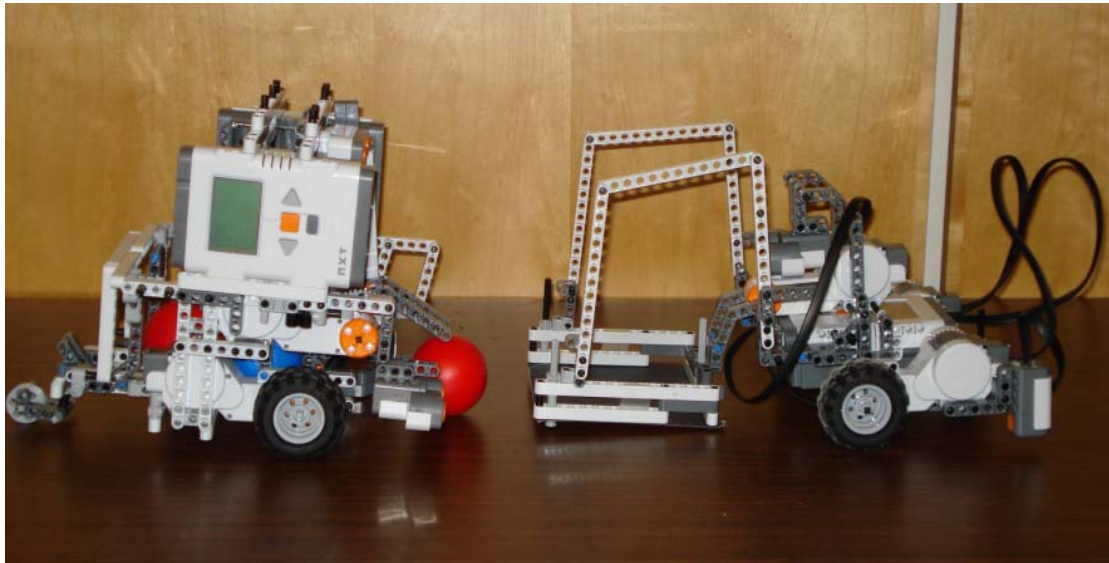
Loader with Ball 2



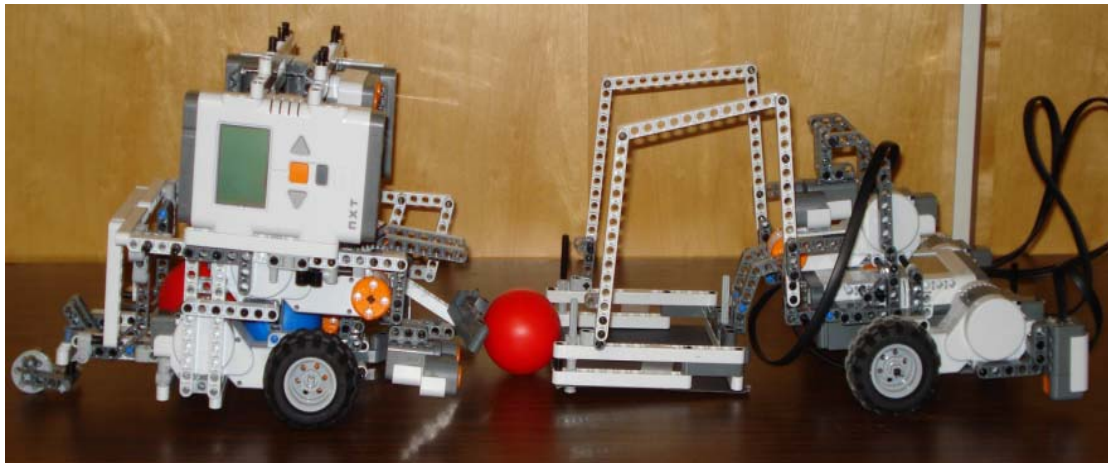
Loader with ball 3



Loader and Scooper 1



Loader and Scooper 2



Loader and Scooper 3

