

Green Team

EECS 498 W17

Project 1 Assembly Instructions

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Complete Assembly:

The robot consists of three different subsystems. The detailed assembly instructions of these subsystems can be found in the subsequent sections.

A. Chassis



Figure 1: Side view of the chassis subsystem

B. Track



Figure 2: Overhead view of the track

C. Gantry

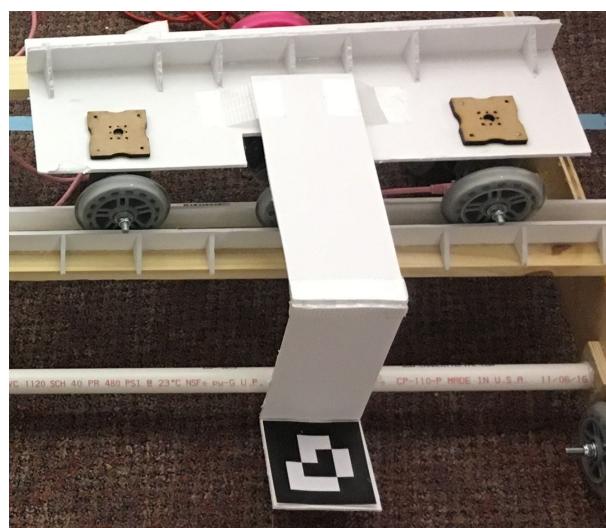


Figure 3: Overhead view of the Gantry Subsystem

A. Chassis Subsystem:

a. Constructing Side Walls

1. Take a sheet of $\frac{1}{2}$ -inch thick wood.
2. Mark two rectangles of 23 inches by 4.5 inches, and cut them from the wood.

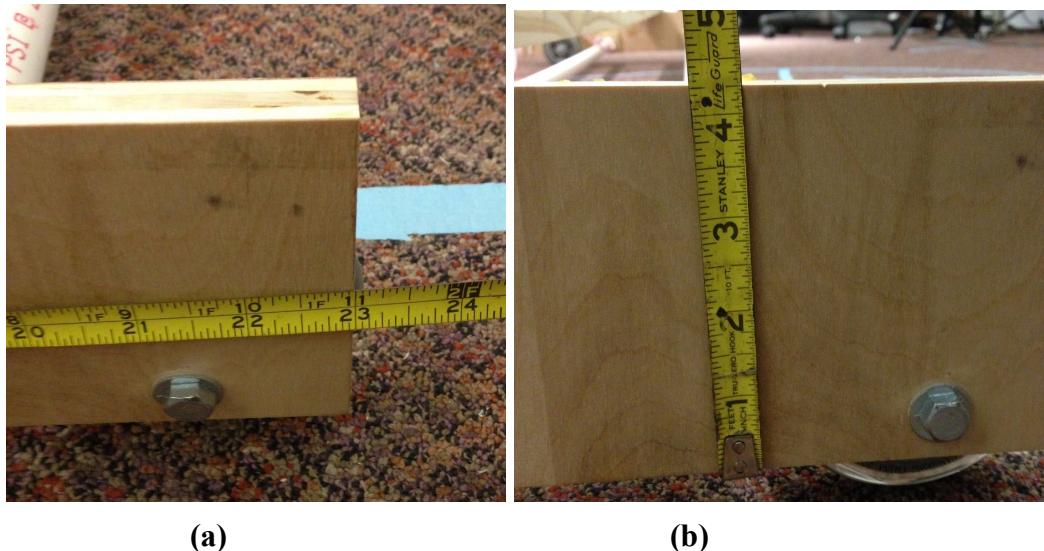


Figure 4a, 4b: Side view of the side bars .Ruler provided for length and width reference.

b. Constructing PVC Bars

1. From $\frac{1}{2}$ -inch plywood, cut four 2 inch by 2 inch squares.
2. Mark the center of each of these squares, and, using a $\frac{3}{4}$ -inch hole saw, drill a hole in each.
3. Take the two 2 meter long, $\frac{3}{4}$ -inch diameter PVC pipes, and make sure that they fit into the holes in the wood squares. If they do not, use a chisel to widen the holes until they do. Make sure to use a file to deburr the holes.
4. Using superglue, attach the PVC pipes to the wood squares.



Figure 5: Overhead view of connecting wood block. Ruler provided for length reference.

c. Attaching the Free Wheels to the Side Walls

5. On each of the side walls, make a mark 1.5 inches from the short side and .75 inches from the long side.
6. Drill a hole of diameter $\frac{3}{8}$ inch at each of these marks.
7. Pass a 2.5 inch bolt through each of the holes, leaving a $\frac{1}{2}$ inch diameter washer on each side.
8. Add a nut, then another $\frac{1}{2}$ inch diameter washer to each bolt.
9. Add the scooter wheel, then another $\frac{1}{2}$ inch diameter washer, then a fixed nut to each bolt.



Figure 6: View of the fixed nut and washer on a free wheel

10. Tighten the fixed nut until the scooter wheel cannot wobble laterally.
11. Ensure that the wheels are able to spin freely; if they are not, loosen the fixed nut slightly.

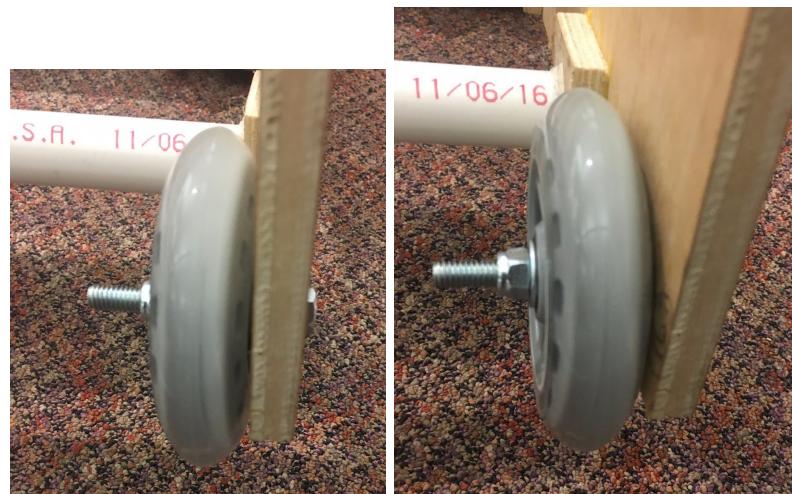


Figure 7a,7b: Side view of wheels connected to the sidebars of chassis

d. Attaching the PVC Bars to the Side Walls

12. Make marks 3.5 inches and 5.5 inches from the short edge of the side wall, on the side with the wheel.
13. Using hot glue, glue the wood squares to the side walls, such that the bottom edge of the wood squares are flush with the bottom edge of the side wall, and the sides of the wood are even with the marks made in the previous step.
14. Make marks 12.5 inches and 14.5 inches from the short edge of the side wall, on the side with the wheel.
15. Using hot glue, glue the wood squares to the side walls, such that the bottom edge of the wood squares are flush with the bottom edge of the side wall, and the sides of the wood are even with the marks made in the previous step.

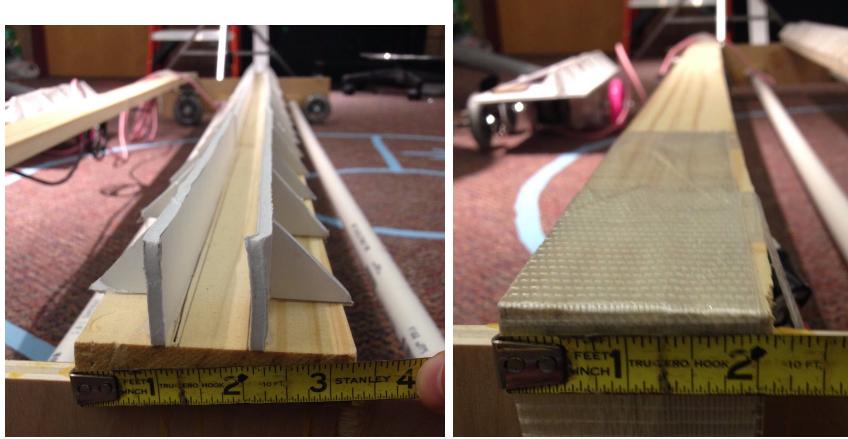


Figure 8: PVC connection to wood square & placement on side wall

B. Track

a. Constructing the Track

1. Take a sheet of $\frac{1}{2}$ -inch thick wood.
2. Mark two rectangles 6ft by 3 inches, 6ft by 2 inches and cut them from the wood.



(a)

(b)

Figure 9a,9b: Side view of the two tracks. Ruler provided for length reference.

3. Take a foamcore board and cut 5 rectangles of 30 inches by 1 inch
4. Align these rectangles vertically as a track along the 6ft by 3 inches wood rectangle as shown below using hot glue.



Figure 10: Side view of the track on the wood

5. Cut small squares of 1 inch by 1 inch as needed and cut through the diagonal of the squares to form the triangles as shown in the picture below.



Figure 11: Foamcore Triangles

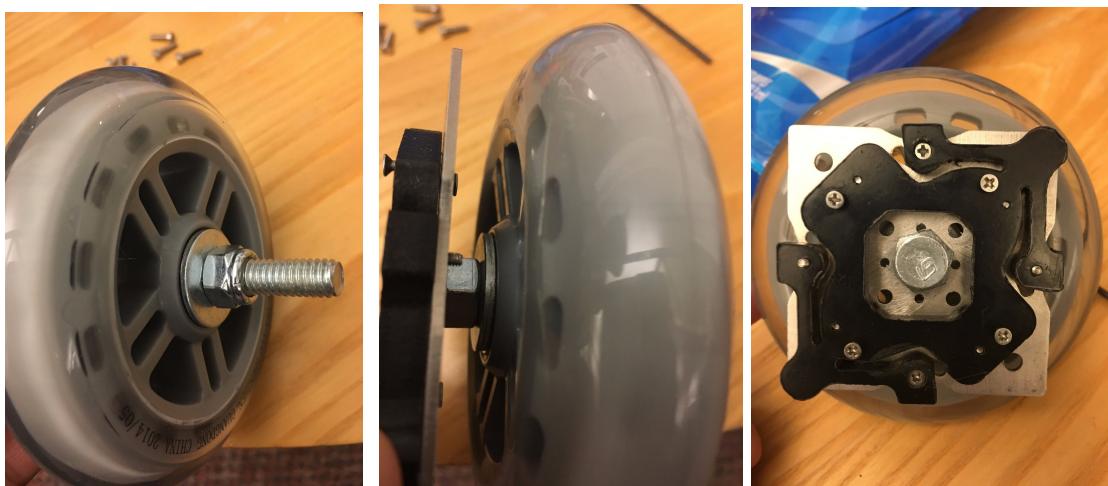
6. Align these triangles along the track of the foamcore as a support using hot glue.

b. Attaching the track to the Chassis Subsystem

7. Make marks of $7\frac{1}{2}$ inch from one end of the side walls and $3\frac{1}{2}$ inch from the other end.
 8. Place the 6ft by 3 inch track at the $7\frac{1}{2}$ inch mark and attach it using wood glue and clamp it for half an hour.
 9. Place the 6ft by 2 inch track at the $3\frac{1}{2}$ inch mark and attach it using wood glue and clamp it for half an hour.

c. Attaching the Powered Wheels to the Side Walls of the Chassis and the Track

10. Pass a 2.5 inch long, $\frac{3}{8}$ inch diameter bolt into a metal plate, nut, $\frac{3}{4}$ inch washer and a scooter wheel, then place a $\frac{3}{4}$ inch diameter washer, then a fixed nut to the bolt. This is a fixed-wheel unit.



(a) **(b)** **(c)**
Figure 12a, 12b, 12c: Side view of wheel attached to a metal plate and a snaplock

11. Tighten the fixed nut until the scooter wheel cannot rotate on the bolt.
 12. Using a plastic snaplock connector, attach the metal plate of the fixed wheel unit to the fully rotating plate of a MX-64 servo motor.
 13. Trace a metal snaplock plate onto a foamcore board and cut it out.
 14. On the fixed metal plate on the servo motor that is not part of the U-bar, stack the foamcore square created in the previous step and a wood snaplock block.
 15. Using four wood screws, secure the metal plate to the wood block with the foamcore in between. Make sure to screw from the side of the metal plate.

16. Stack five additional wood blocks on top of the one that is attached with screws, and secure them by passing tape from one side of the metal servo motor plate, over the stack, and down to the other side of the metal servo motor plate.
17. Place the motor and wood block stack in the corner of the 2 inch track and the side wall with the wheel pointing inwards.
18. Use tape to secure the motor in this position. Tape should be placed in two locations: first, from the top of the wood track then down around the sides of the wood block stack; second, from the bottom of the U-bar, around the side wall, and up onto the wooden track. Make sure the tape is taut, and use multiple layers until the wheel and motor cannot wobble. Make sure that the tape is in tension so the motor is fixed to the wood.

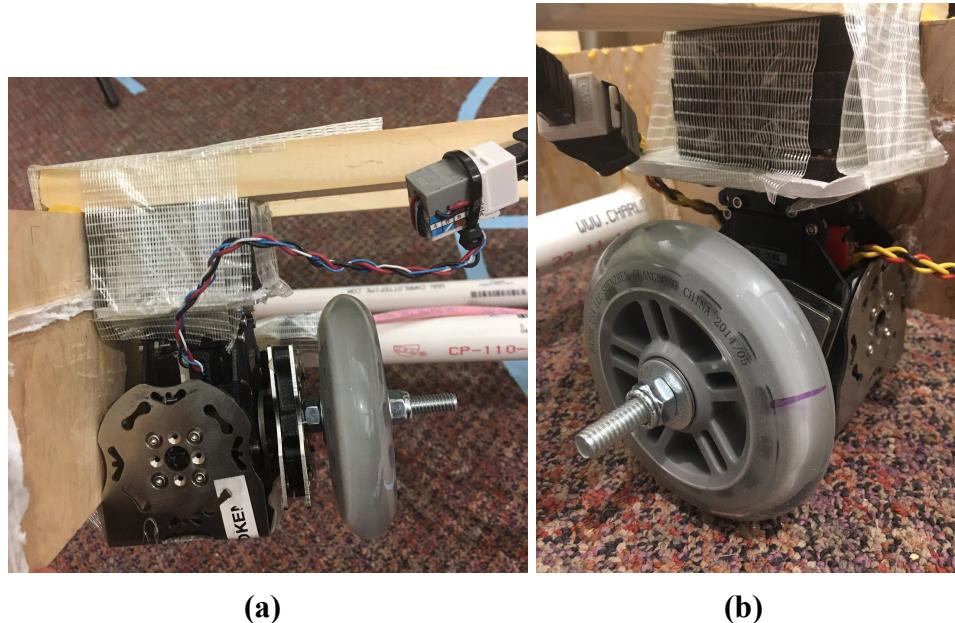


Figure 13a, 13b: Side view of the wheels snaplocked to the motors and taped to the chassis/track

C. Gantry Subsystem

a. Gantry Base

1. Cut a 53 cm by 19 cm rectangle from foam core. This will be the gantry base. On the 53 cm side, make marks at 8.5, 26.5, and 44.5 cm from the edges. These will mark the midpoints of the wheels.
2. Measure 1.5 cm from the long edge and mark it with a line along the entire edge. This will mark the close edge of two free wheels.
3. Place a metal snaplock plate such that one edge is on the 1.5 cm line and its midpoint is on the 8.5 cm line. Screw wood screws through two opposite corners to mark the location, then unscrew them.



Figure 13: Free wheel snaplock placement and element layering

4. Repeat step 3, using the 44.5 cm line as the midpoint.
5. For each snaplock, stack, from bottom to top, a metal snaplock plate, plastic spacer, the gantry base, and a wood block, such that the corner holes all line up with the screw holes created in steps 3 and 4.
6. Put the screws in from the side with the metal plates, and screw until all four pieces are tight. These will be the mounts for free-spinning wheels.
7. Cut a rectangle 4 cm deep out of the long end of the foamcore from 20.5 to 32.5 cm. This is a wheel well that will allow the powered motor to rotate.

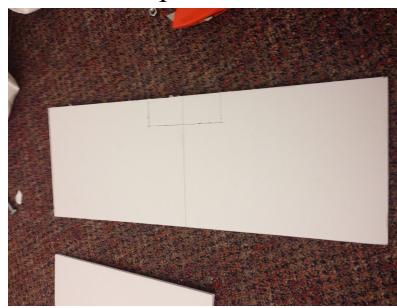


Figure 14: Gantry base with wheel well marked

8. Place a metal snaplock plate such that one edge is on the wheel well cut out in step 7 and its midpoint is on the 26.5 cm line. Screw wood screws through two opposite corners to mark the location, then unscrew them.



Figure 15: Powered wheel snaplock placement and wheel well location

9. Stack the snaplock pieces as described in step 5, and attach as described in step 6. This snaplock will be the mount for the powered wheel and the balancing wheel.



Figure 16a, 16b: Top and bottom views of gantry base with wheel placement

b. Reinforcement Ridge

10. Cut a 53 cm by 3.5 cm rectangle out of foamcore. Using hot glue, attach it to the larger rectangle at 4.5 cm from the long edge that does not have a wheel well.

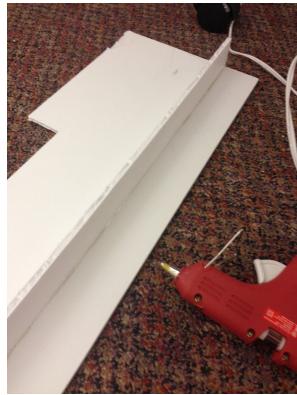


Figure 17: Reinforcement ridge

11. Cut 14 right triangles with bases of 3.5 cm from foamcore. This will be the reinforcement ridge. Using hot glue, secure them in the corners between the gantry base and the reinforcement ridge.



Figure 18: Foamcore triangle placement for reinforcement ridge

c. Powered Wheel and Balancing Wheel

12. Take a Dynamixel MX-64 servo motor that has been configured for full rotation. Attach a plastic snaplock to the rotating metal plate.
13. Put the 6.5 inch long, $\frac{3}{8}$ inch diameter bolt through a metal snaplock plate.
14. Thread 5 nuts down the bolt so that it is secured to the metal plate.
15. Run a $\frac{3}{4}$ inch diameter washer down the bolt, followed by a scooter wheel, followed by another $\frac{3}{4}$ inch diameter washer.
16. Thread a fixed nut down the bolt until the scooter wheel cannot spin freely.



Figure 19: Powered wheel bolt with parts tightened down

17. Attach the metal plate to the plastic snaplock on the rotating metal plate of the servo motor.

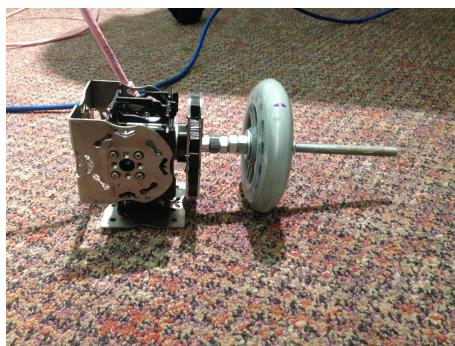


Figure 20: Powered wheel attached to servo motor

d. Free Wheels

18. Take a metal U-bar, and run a 2.5 inch bolt through one of the sides. This will
19. Thread two nuts down the bolt to secure it to the U-bar.
20. Run a $\frac{1}{2}$ inch diameter washer down the bolt, followed by a scooter wheel, followed by another $\frac{1}{2}$ inch diameter washer.
21. Thread a fixed nut onto the bolt, then tighten it until the wheel can spin freely but not wobble.



Figure 21: Free wheel attached to U-bar

22. Repeat steps 18-21 two more times, until there are three free-wheel units.

e. Attach Wheels

23. Using a plastic snaplock, attach the side of the U-bar opposite one free wheel side of the servo motor opposite the wheel attached in step 17.

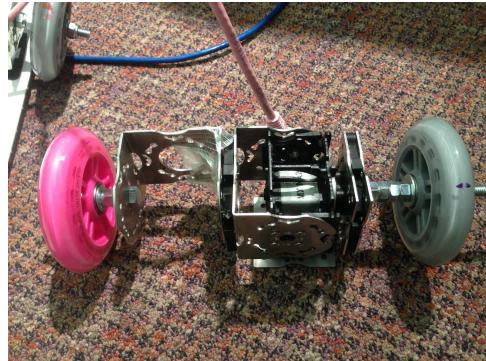


Figure 22: Powered wheel attached to free balancing wheel

24. Using a plastic snaplock, attach one of the sides of the U-bar on the servo motor to the metal plate adjacent to the wheel well that was attached in step 9.

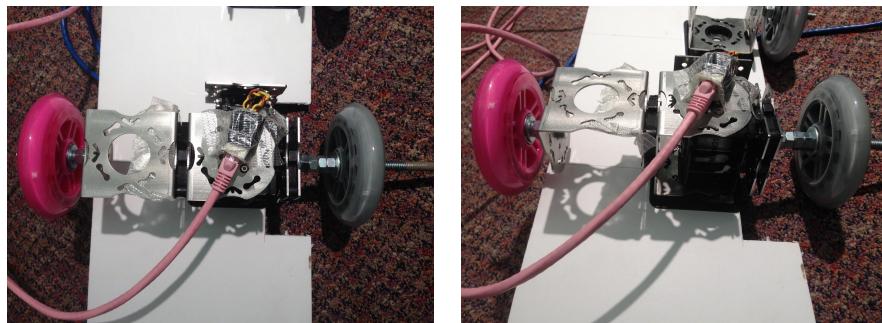


Figure 23a, 23b: Powered and balancing wheel placement on gantry base

25. Attach the middle section of the U-bar of the other two free wheels to the metal plates attached in steps 8 and 9 using a plastic snaplock. These will be the alignment wheels.

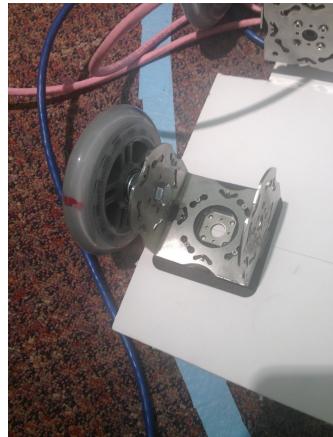


Figure 24: Alignment wheel placement on gantry base

f. Tag Holder

26. Cut three foamcore rectangles of 28 cm by 10 cm, 22 cm by 10 cm, and 10 cm by cm.
27. Using hot glue, attach the 28 cm rectangle to the 22 cm rectangle at a right angle.
28. Using hot glue, attach the 22 cm rectangle to the 10 cm rectangle, such that the two are at a right angle and the 10 cm rectangle is on the opposite side of the 22 cm rectangle as the 28 cm rectangle. The structure should look as pictured below.



Figure 25: Tag holder arm

29. Cut four right triangles with bases of 3.5 cm from foamcore, and glue one into each side of each right angle, as shown below.



Figure 26: Triangle reinforcement at one joint

30. Tape the tag to the 10 cm square, as shown above.
31. Tape the structure on the center of the gantry so that it extends over the wheel well.

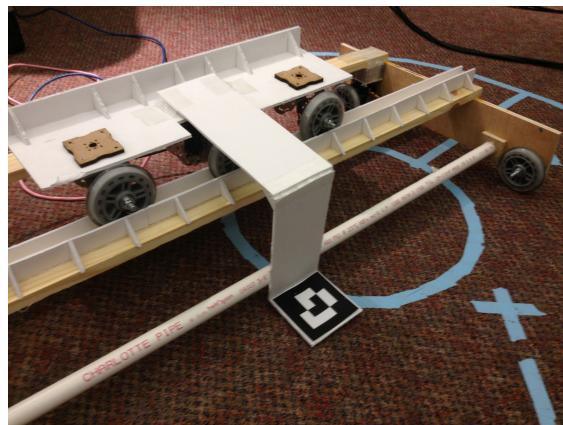


Figure 27: Tag holder placement on gantry

32. Place the gantry on the track so that the side with three wheels is on the track with walls, as shown above.