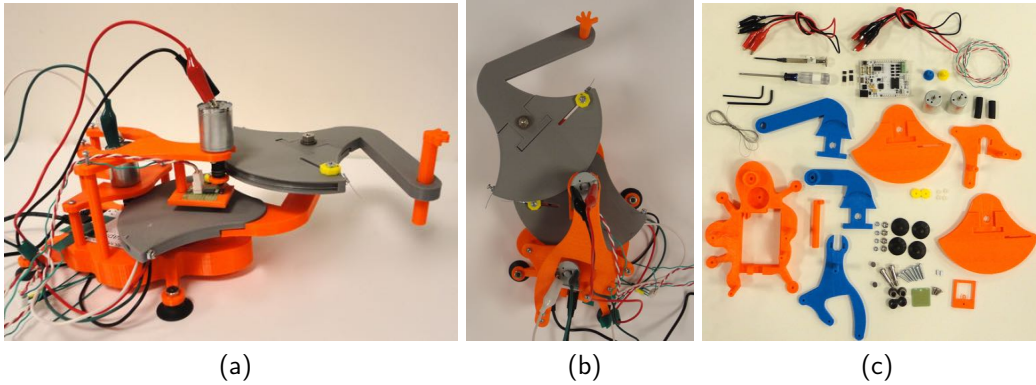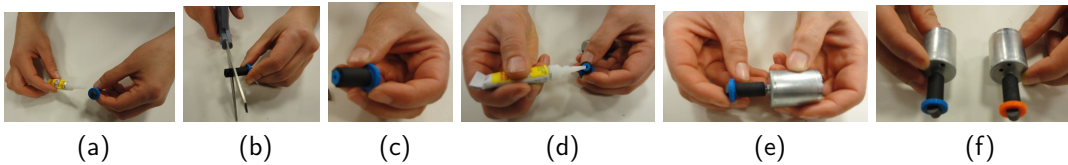# Haplink Assembly Instructions
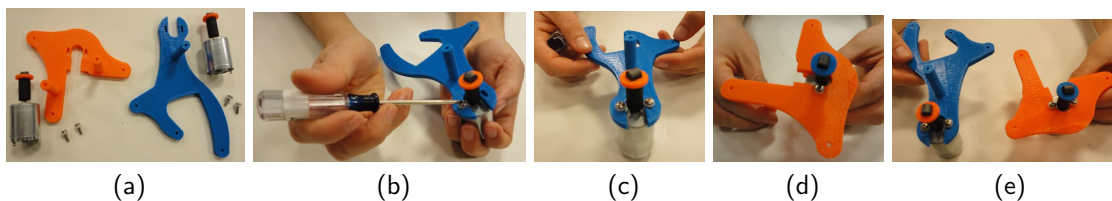Version 01.23.2017

(a)   (b)   (c)

1. **Obtain the Haplink Components:** Consult the parts list provided on the website.

2. **Use a 3-D printer to create the 3-D printed parts.** The STL files for all the 3-D printed components you need to create Haplink are on the Hapkit website. The CAD files are also available. We recommend that you customize and create your own User Handle.

3. **Assemble your motors.** (a) Glue the magnet to the drive wheel. (b) Cut the rubber tube and fit it (c) on the drive wheel. Make sure there is a tiny portion of the driver wheel's plastic still showing. (d) Put some super glue in the drive wheel (NOT TOO MUCH! A drop is enough!) and (e) attach it to the motor. (f) Repeat for the other motor.

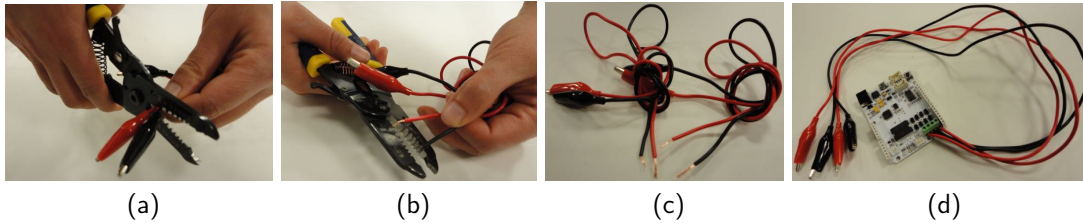(a)   (b)   (c)   (d)   (e)   (f)

4. **Attach your motors onto their mounts.** (a) For this step you will need four 4-40 screws of length 3/8", four washers, the two motors you assembled in step 3 and your two motor mounts. (b) Attach one motor one motor mount using the screws and washers. (c) Try to place the motor as far forward as possible on the slots (you may need to adjust a little later). (d)Repeat for the other motor mount. (e) Watch the placement of the motors on the mounts. Follow the figures to make sure you don't attach them backwards.

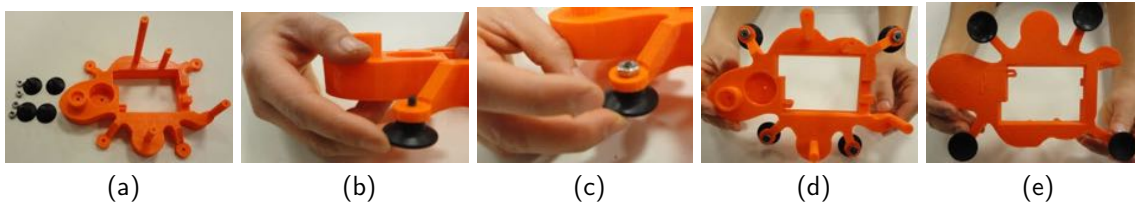(a)   (b)   (c)   (d)   (e)

5. **Attach the alligator-clip cables onto the Hapkit Board's motor connector.** (a) Cut the heads off the alligator-clip cables on one side. (b) Strip the rubber off the cables on the
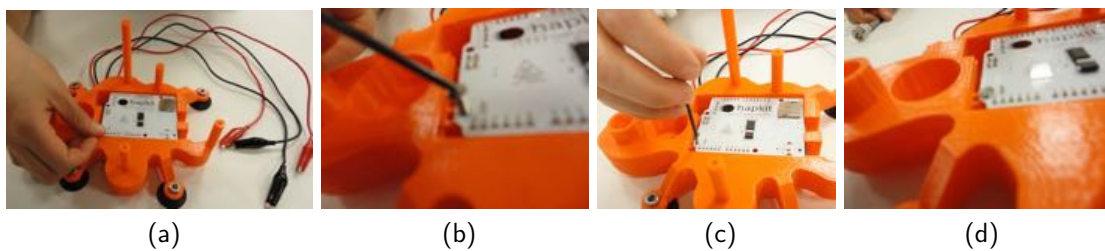
same side you cut the heads from. (c) Strip about 1/4". (d) Use the screwdriver to unscrew the four terminals on the right side of the Hapkit board. This will open up holes on the right side of the terminal block so you can insert the stripped wire end. Please be mindful of the fact that the motor connector is labeled M1+, M1-, M2-,M2+. Make sure you remember which cable goes to which connector. We recommend that you use different colored alligator cables for this purpose.
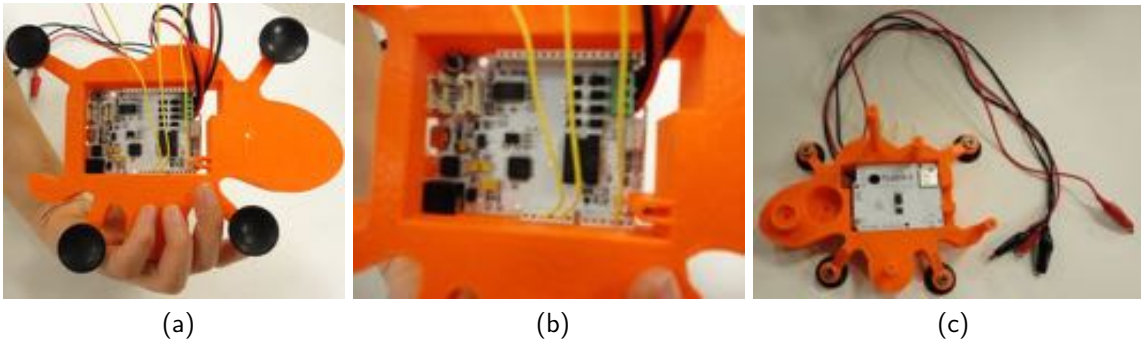

| (a) | (b) | (c) | (d) |

6. **Attach the suction cups to the base** (a)-(b) Put the suction cups through the 4 holes at the feet of the base. (c) Use 11/32" nuts on the threads of the suction cups to fasten them. (d)-(e) check that you placed them in the correct orientation.
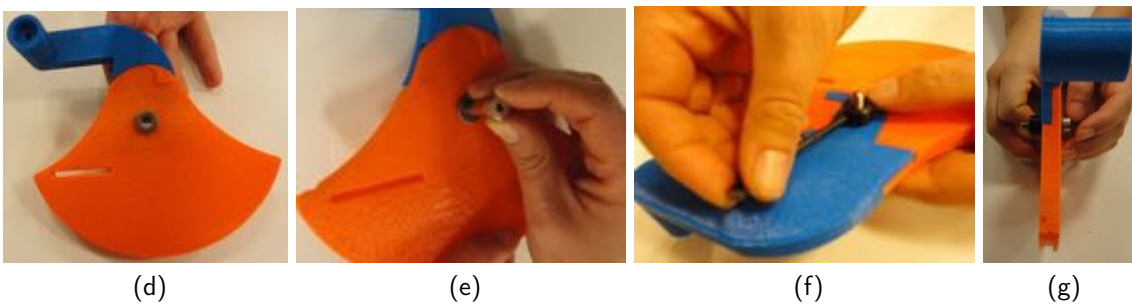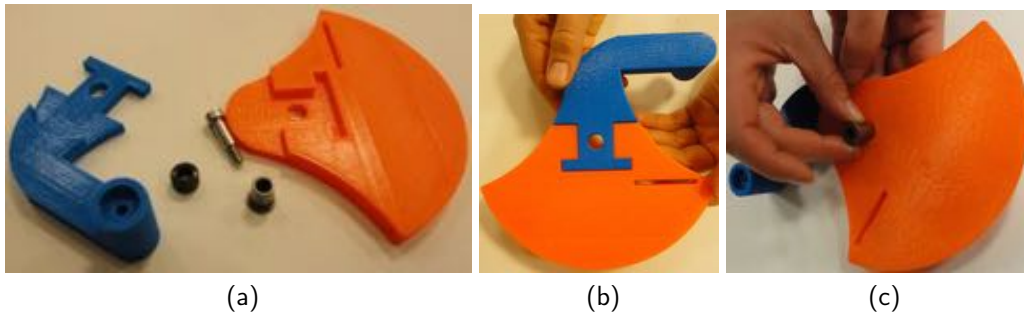

| (a) | (b) | (c) | (d) | (e) |

7. **Attach the Hapkit Board to the base** (For this step we assume that the Hapkit Board already has a magnetoresistive (MR) sensor soldered onto it following Step 9 of the 3-D printed Hapkit assembly instructions). (a) Make sure that you place the board as far right as it can go with the MR sensor on top. The alligator cables attached to it should come out from the bottom and be placed to the back of the device. (b)-(d) Use one 4-40 3/4" screw to attach the Hapkit Board in place

| (a) | (b) | (c) | (d) |

8. **Insert the jumper sensor wires in the Hapkit Board** Turn the Assembled base plus board around so you can look at the headers on the Hapkit Board. We need to run 3 wires from the Hapkit Board to the back of the device where the motor wires are. (a)-(b) Connect three jumper wires: One to Gnd, one to 5V and one to Analog 3 (A3). (c) Place the base right side up again. We recommend you mark the jumper wires you just placed so you don't forget which is which. We will later connect them.

(a)   (b)   (c)

9. **Assemble Sector Pulley A.** Sector Pulley A will be paired with motor 1. (a)-(b) Press to fit Handle A into the Sector Pulley. Due to the tolerance of the 3-D printer it may be a little tight or loose. In the case that it is too loose, please use super glue to attach it. (c)-(d) With the sector pulley laying flat on the table, insert the bearing into the hole on the side that would normally be the back of the Sector Pulley. Again here the fit may be a little tight or loose. In the case that it is tight you may use a light hammer to press it in. (e) Insert the shoulder screw into the bearing. It should turn freely in the bearing. (f) Place the shaft collar over the shoulder screw and use the 3/32" hex key (allen wrench) to securely attach the shaft collar to the bolt (not screw) part of the shoulder screw. (g) After assembly, you should be able to hold onto the screw part of the shoulder screw and freely swing the sector pulley around the bearing.

(a)   (b)   (c)

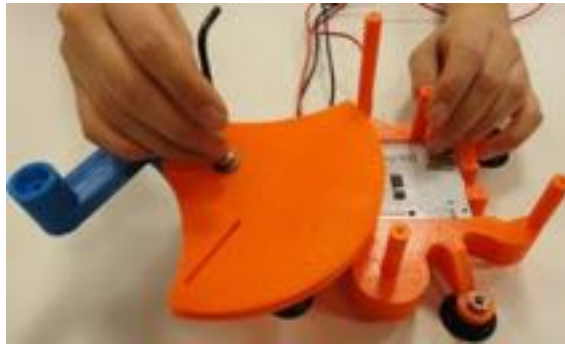(d)   (e)   (f)   (g)

10. **Attach Sector Pulley A to the base.** (a)-(b) Place the shoulder screw (on Sector Pulley A's assembly) into the hole on the base piece marked in Figure 10(a). Use the 1/8" hex key (allen wrench) to screw the shoulder screw into the hole. You will be tapping (creating threads in the plastic of the hole) as you screw it in, so be sure to make the screw go in as straight as possible. You need to screw it until a secure attachment is made.

Attach Sector Pulley A here!

(a)   (b)

11. **Attach Motor Hold 1 to the base.** (a)-(b) Align the Motor Hold 1 holes with the posts marked in Figure 11(a). (c) Use three 4-40 3/4" screws to attach the Motor Hold 1 to the posts. You will be tapping as you screw in, so be sure to make the screw go in as straight as possible. Depending on tolerance with 3-D printers, you may need to drill the holes to make them a little bit bigger. If they are too big however, you may use larger screws or some super glue. (d) Be aware of orientation, the motor magnet should be facing downward and centered on the MR sensor when you are done.

Motor Hold 1 attaches here!
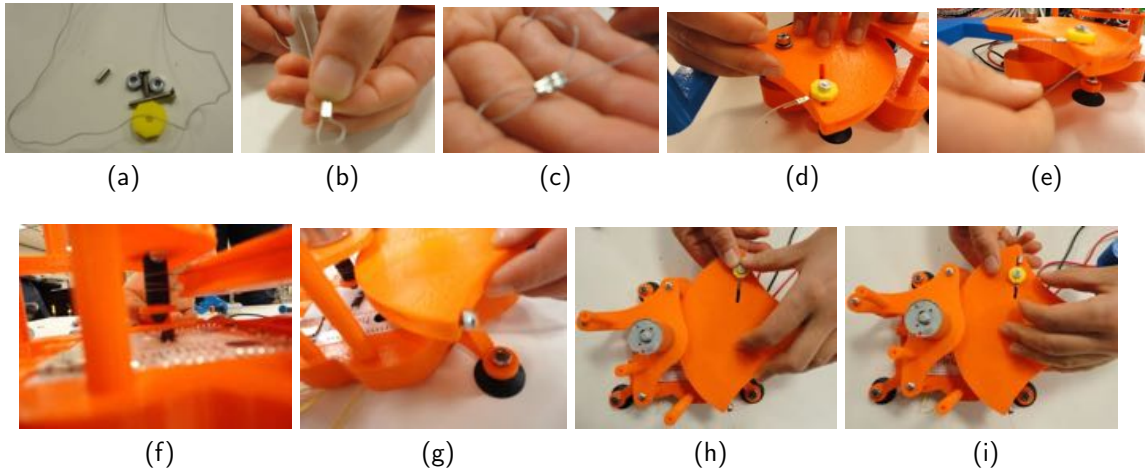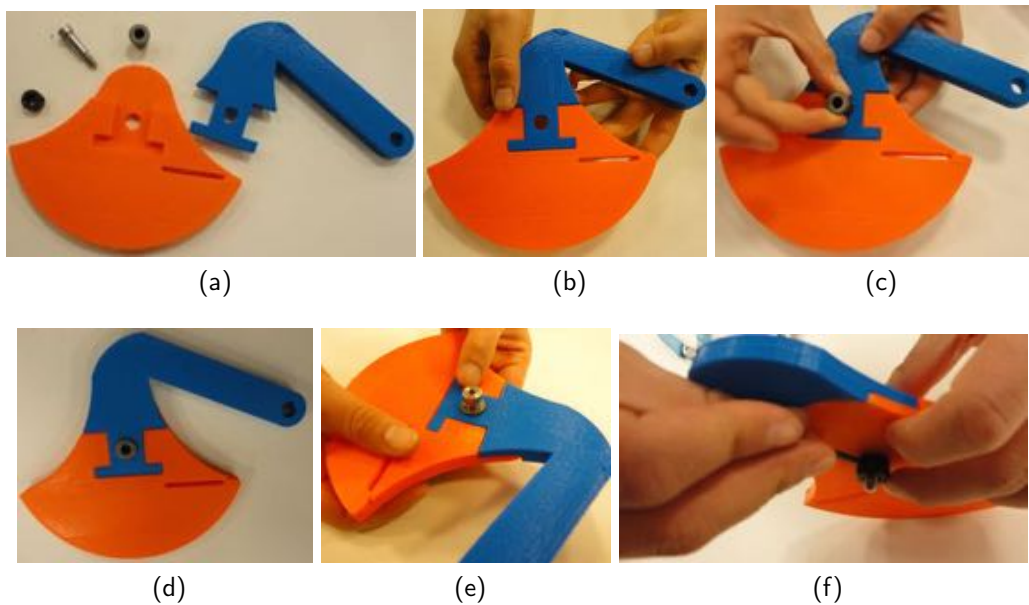
(a)   (b)   (c)   (d)

12. **Assemble the cable driving system for Sector Pulley A.** (a)-(c)Put one end of the cable through the compression sleeve and form a ring. Use the crimping tool to crimp the compression sleeve so that the cable can't move in the sleeve. (d) Place a 4-40 3/4" screw from the back of the sector pulley through the long slot and the ring at the end of the cable. Put the 3-D printed tightening washer and a 4-40 nut on top and tighten it. (e) Put the other end of the cable through the small hole on the bottom left corner of the sector pulley. (f) Pull the cable along the sector pulley and around the drive wheel for 3 loops. Note that it is important to loop under the drive wheel and then around. (g) Pull the end of the cable through the hole on the other end of the sector pulley. Screw the 4-40 1/2" screw with a nut into the hole to fasten the cable. (h) Loosen the 3-D printed washer a little and push it as far forward on the slot as it will go. (i) Tighten the washer again. This will tighten the cable drive. *Note: This step is quite difficult for novices. The posts on the motor hold make it especially challenging, but please be patient and remember you can always reference Hapkit 3.0 assembly instructions for more tips.*
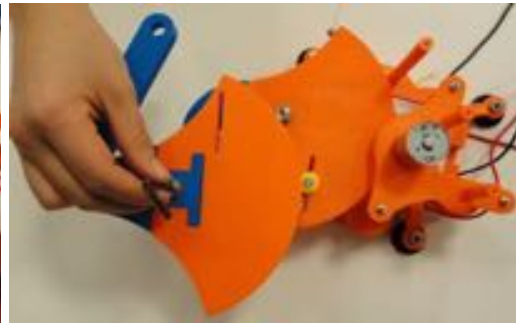
(a) (b) (c) (d) (e)

(f) (g) (h) (i)

13. **Assemble Sector Pulley B.** Sector Pulley B will be paired with motor 2. (a)-(b) Press to fit Handle A into the Sector Pulley. Due to the tolerance of the 3-D printer it may be a little tight or loose. In the case that it is too loose, please use super glue to attach it. (c)-(d) With the sector pulley laying flat on the table, insert the bearing into the hole on the front side (Note that this is opposite to Sector Pulley A). Again here the fit may be a little tight or loose. In the case that it is tight you may use a light hammer to press it in. (e) Insert the shoulder screw into the bearing. It should turn freely in the bearing. (f) Place the shaft collar over the shoulder screw and use the 3/32" hex key (allen wrench) to securely attach the shaft collar to the bolt (not screw) part of the shoulder screw. After assembly, you should be able to hold onto the screw part of the shoulder screw and freely swing the sector pulley around the bearing.

(a) (b) (c)

(d) (e) (f)

14. **Attach Sector Pulley B to Sector Pulley A's handle.** (a)-(b) Place the shoulder screw (on Sector Pulley B's assembly) into the hole on the handle of Sector Pulley A. Use the 1/8" hex key (allen wrench) to screw the shoulder screw into the hole. You will be tapping (creating threads in the plastic of the hole) as you screw it in, so be sure to make the screw go in as straight as possible. You need to screw it in until a secure attachment is made.
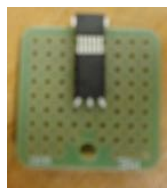
(a)　　　　　　　　　　　　　　　(b)

15. **Assemble the sensor for motor 2** (a)-(c) Solder the sensor onto the breadboard. The sensor should be placed so there is only one line on holes in between it and the screw hole of the breadboard. You should also solder a header or wires to bring out the sensor pins. (d)-(e) Place the breadboard with the sensor and the header on the sensor hold and use a 3/4" screw to attach it to Motor Hold 2. Here make sure that the motor's magnet is centered with the top part of the senor. You may need to readjust the motor in its slot a little to make sure it is so.

(a)　　　　　(b)　　　　　(c)　　　　　(d)　　　　　(e)

16. **Attach Motor Hold 2 to the base.** (a)-(b) Align the Motor Hold 2 holes with the posts on the base and Motor Hold 1. Use three 4-40 3/4" screws to attach the Motor Hold 2 to the posts. You will be tapping as you screw in, so be sure to make the screw go in as straight as possible. Depending on tolerance with 3-D printers, you may need to drill the holes to make them a little bit bigger. If they are too big however, you may use larger screws or some super glue.
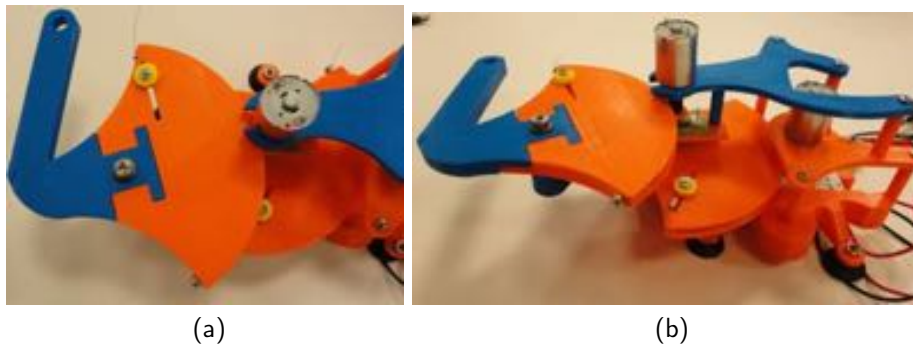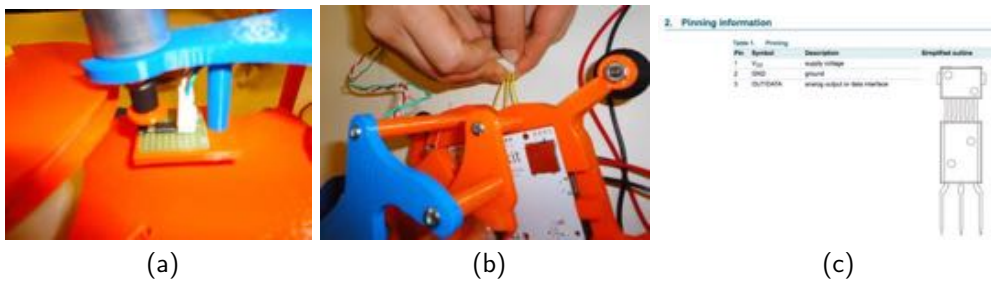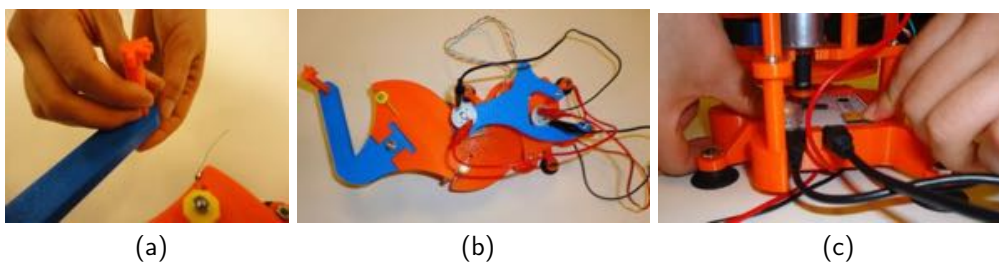

(a)　　　　　　　　　　　　　　　(b)

17. **Assemble the cable driving system for Sector Pulley B.** (a)-(b) Follow the steps from Step 12 for Sector Pulley B and motor 2.

(a)   (b)

18. **Connect sensor 2 to the Hapkit Board** (a)-(c) Connect a cable from the header on the sensor board to the three cables we connected to the Hapkit board on Step 8. Make sure you are careful and follow the datasheet of the Magnetoresistive sensor illustrated in figure 18(c). Vdd needs to be connected to 5V, Gnd needs to be connected to Gnd and OUT/DATA needs to be connected to A3.

(a)   (b)   (c)

19. **Get your Haplink Ready!** You are almost done! (a) Insert your User Handle into Sector Pulley B's handle. (b) Connect motors one and two to the Hapkit Board. Make sure to connect the M+ of the Hapkit Board to the side with the red dot on the motor. Also make sure not to touch ever the motor case with the alligator clips. Only connect to the connectors on the motor. (c) Finally connect the power supply and USB cable.

(a)   (b)   (c)

You are ready to start downloading code and playing with your Haplink!