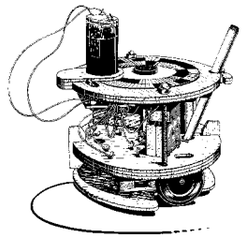


⚠ CAUTION! ★Please read the following instructions before using this kit.

●Use caution when handling any metallic parts that are thin and sharp. Improper use may cause injury.

●To avoid the risk of suffocation, do not swallow small parts. Keep away from small children.

●To avoid the risk of electric shock, do not insert the lead wires into an electric socket.

●Remove the batteries after using the kit and keep them away from small children.

●Be careful not to point your eyes and hands with terminals of the LED (light-emitting diode).

●Keep off magnets from electrical products such as a television set. They may cause a breakdown.

★* Two size C dry batteries are required. Improper use of batteries may cause the generation of heat, explosions or leaks. The following precautions should be taken:

●Do not use rechargeable batteries, such as nickel cadmium batteries. (A rechargeable battery may not be able to maintain a sufficient electric supply.)

● Ensure that the positive and negative terminals on the batteries are facing the right way.

● If any acid from the batteries leaks and comes in contact with an eye, wash the eye in water immediately and consult a doctor. If any battery acid comes in contact with skin or clothes, wash with water immediately.

●Remove the batteries after using this kit.

★Read the assembly instructions and cautions in this booklet carefully before using the kit.

★*For your safety, the assembly instructions and cautions in this booklet should be followed. Do not use any materials that have become damaged or deformed while in use.

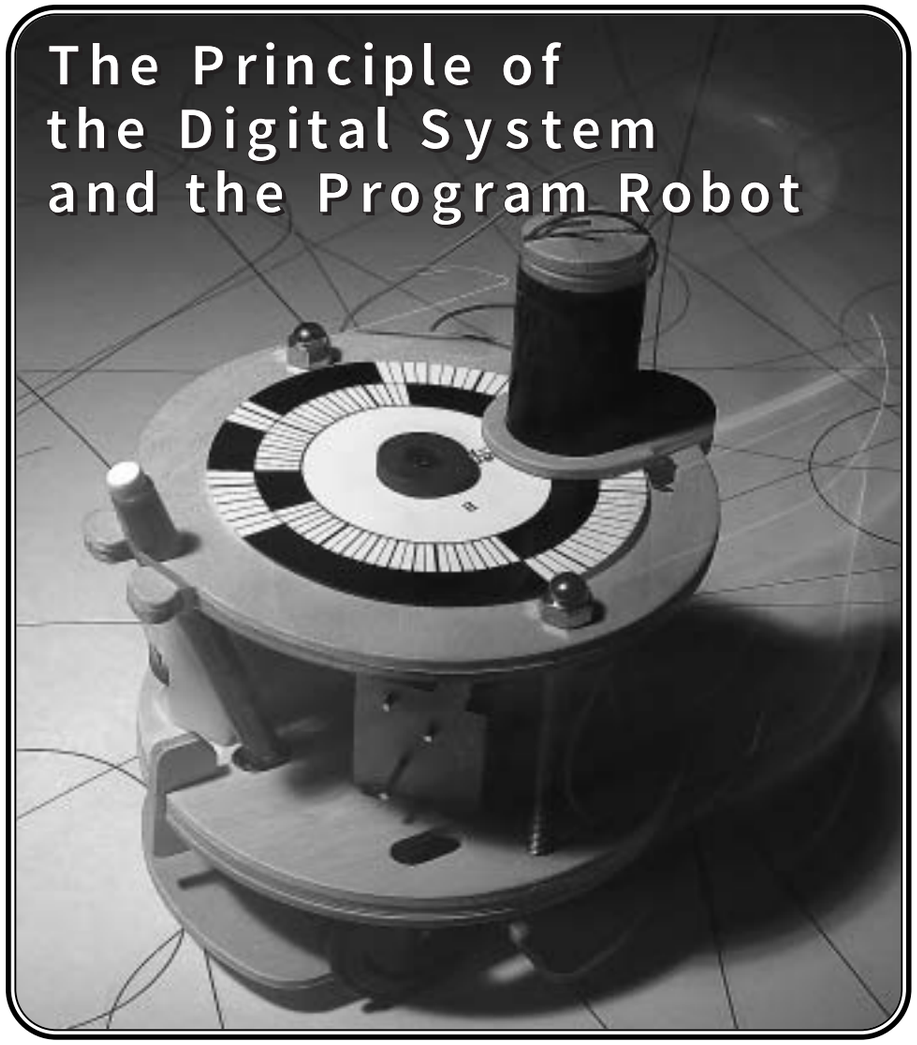
●The plastic materials used in this kit

baseboard (green): polycarbonate
gear of the motor unit (white): Delrin
disk holder (black): polyethylene
light cover (black): polypropylene
plastic bag (transparent): polyethylene
wheel of the motor unit (black): ABS resin
battery box (white): polyethylene
acorn nut (white): polycarbonate
pipe (white): ABS resin

※Vinyl chloride resin is used for the covers of the lead wires.

※When disposing of the kit, please follow the recycling regulations in your area.

The Principle of the Digital System and the Program Robot



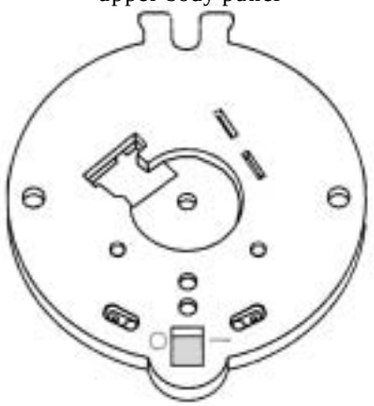
The principle of the digital system is the combination of zero and one in the binary system. This robot represents zero and one by light and shade. The robot reads them with optical sensors (CdS) and controls the movement. That is to say, this robot moves by the principle of the digital system itself.

The real pleasure of this product is that you can write your original programs for the robot easily.

Imagine how the robot moves while you enjoy marking the program disk.

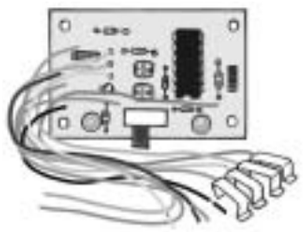
Parts in this Kit

upper body panel

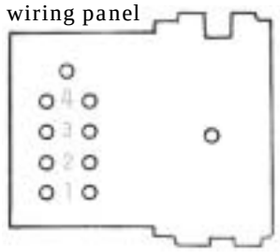


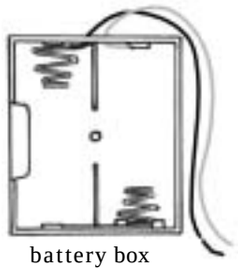
lower body panel

baseboard



wiring panel





battery box

short pipe (4)

small nut (4)

long screw (4)

flat head screw

wing nut

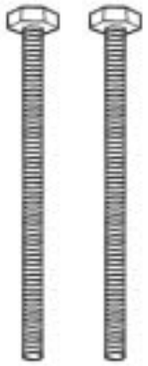
shaft with gear

bearing

long pipe

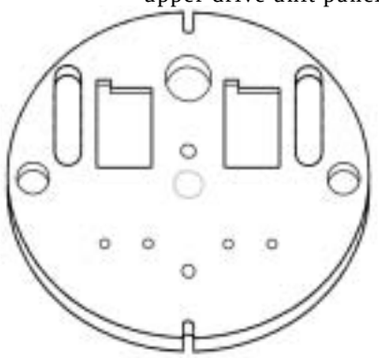
motor unit for the turntable

large acorn nut (2)



large bolt (2)

upper drive unit panel



LED (light-emitting diode)

light cover

upper light stopper

light holder

lower light stopper

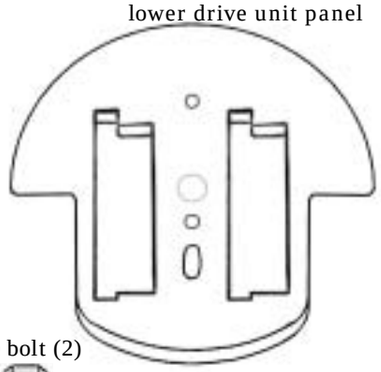
turn table

metallic plate

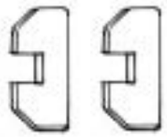
non-slip pad

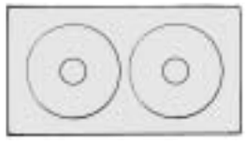
magnet

lower drive unit panel



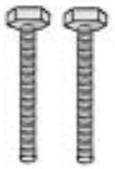
clasp (2)





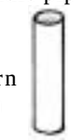
both sides adhesive sticker (2)

middle bolt (2)



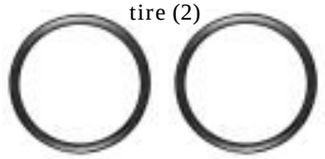
middle nut

middle pipe



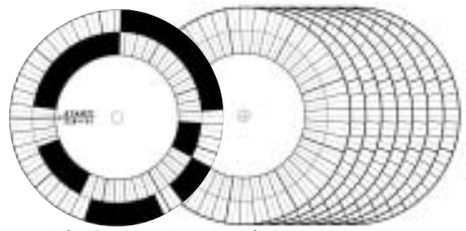
plastic acorn nut (white)

tire (2)



short screw (4)

program disk (19 sheets)



(1 for diagnosis)

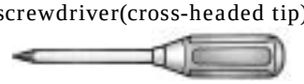
(18 for programming)

left driving motor unit (with a wheel)

right driving motor unit (with a wheel)

Things to be prepared

screwdriver(cross-headed tip)

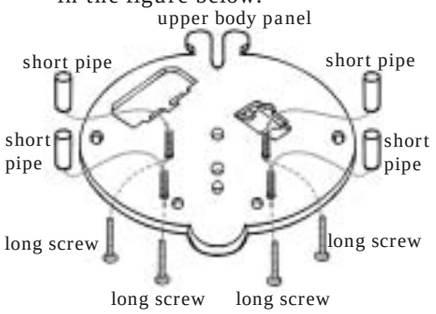


unused size C alkaline battery (2)

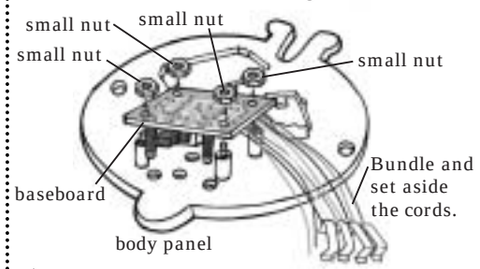
Scotch tape

Let's Assemble the Body!

1 Put 4 long screws through the upper body panel and put each of 4 short pipes on each screw as shown in the figure below.

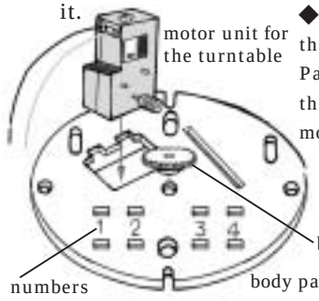


2 Put the long screws into the holes of the baseboard and fasten with small nuts as shown in the figure below.



◆Fit the projecting parts of the base board (light-emitting diodes and optical sensors) into the holes of the body panel.

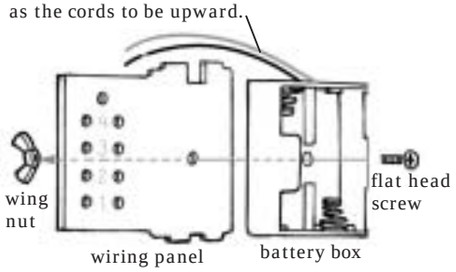
3 Place the lower body panel as shown in the figure and fit the bearing and the motor unit for the turntable into it.



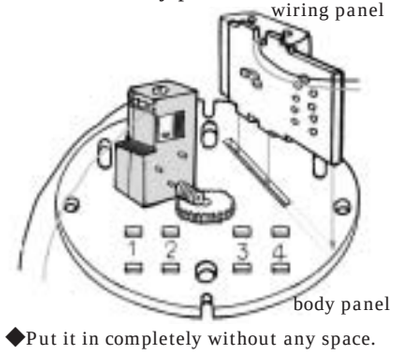
◆Set the side with the numbers up. Pay attention to the direction of the motor unit.

4 Attach the battery box to the wiring panel with the flat head screw and the wing nut.

◆Attach the battery box so as the cords to be upward.

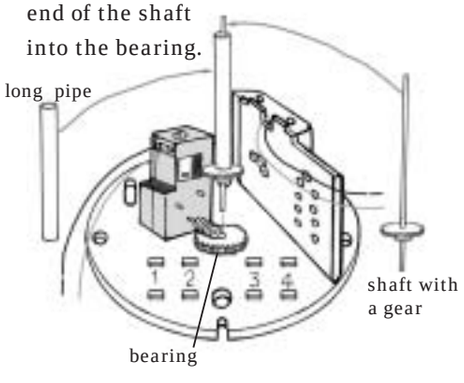


5 Fit the wiring panel into the lower body panel.

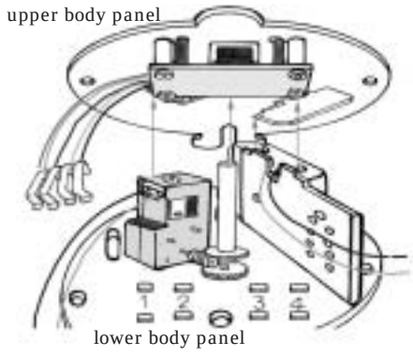


◆Put it in completely without any space.

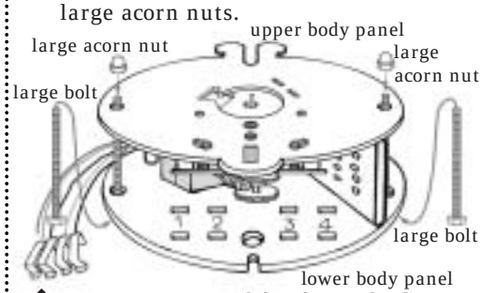
6 Put the long pipe on the longer part of the shaft with a gear. Then insert the opposite end of the shaft into the bearing.



7 Fit the upper body panel into the lower body panel.



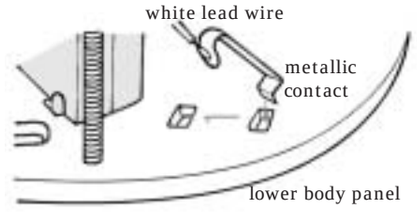
8 Fasten the lower body panel and the upper body panel with large bolts and large acorn nuts.



◆Screw acorn nuts with hands completely without using any tools.

Let's Wire the Robot!

1 Attach the metallic contacts at the tip of the lead wire coming out of the baseboard to the lower body panel. First, fit the metallic contact at the tip of the white lead wire into the hole #1.

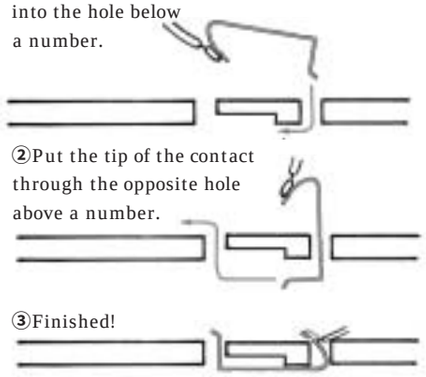


【Cross section】

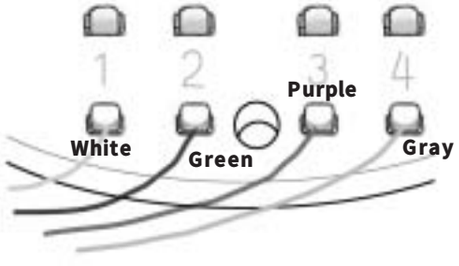
①Put the metallic contact into the hole below a number.

②Put the tip of the contact through the opposite hole above a number.

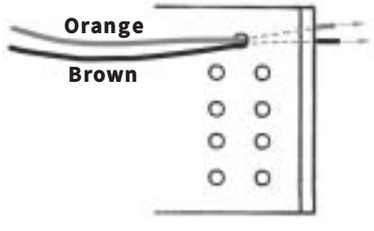
③Finished!



2 Attach other metallic contacts to the lower body panel in the same way.

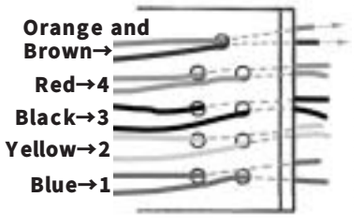


3 Put the brown and the orange lead wires coming out of the baseboard through the top hole of the wiring panel from the inside to the outside (with the numbers engraved).

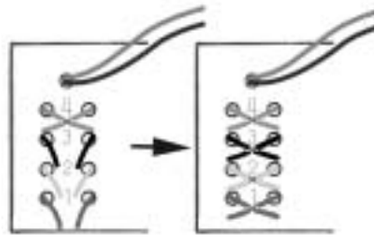


4 Put other lead wires through the 4 holes (from No.1 through 4) of the wiring panel respectively. Pay attention to the combination of the number of a hole and the color of a lead wire. Put each wire through from the inside (with no numbers engraved) to the outside.

◆There are two lead wires per color. Put each wire through the two holes at both sides of a number individually.

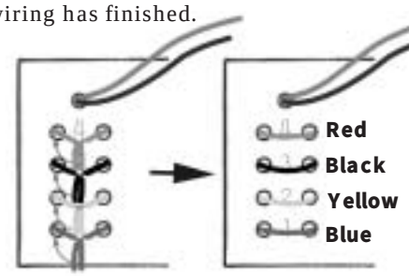


5 Twist the ends of every two wires coming out of the holes No. 1 through 4.



◆Twist the uncovered parts of wires of the same color without taking off the vinyl cover.

6 Put the twisted ends of the wires through each left hole to the other side.Now the wiring has finished.

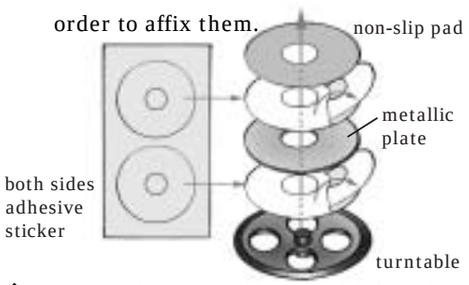


Check!

1. Check the wiring with the left figure. Do the colors of lead wires correspond to hole numbers correctly?
2. Are the metallic contacts at the end of the lead wires coming out of the baseboard inserted in the holes correctly?

Let's Assemble the Scanner Unit

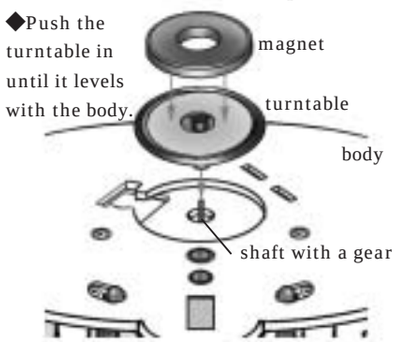
1 Affix the metallic plate and the non-slip pad on the turntable with both side adhesive stickers. Pay attention to the side of the turntable and the order to affix them.



◆The hole at the center of the turntable faces down.

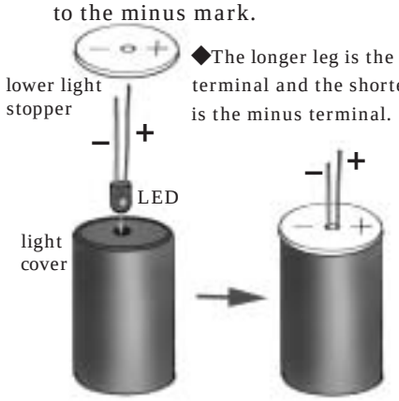
2 Put the turntable on the tip of the shaft with a gear. Put the magnet on the turntable at this point.

◆Push the turntable in until it levels with the body.

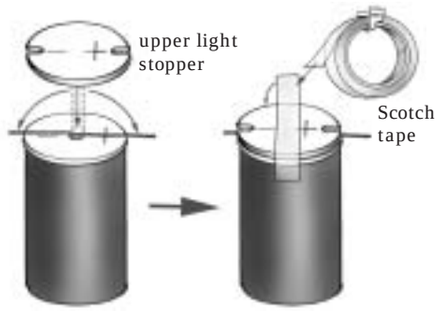


3 Insert the LED in the light cover. Cover with the lower light stopper as the plus terminal comes to the plus mark and the minus terminal to the minus mark.

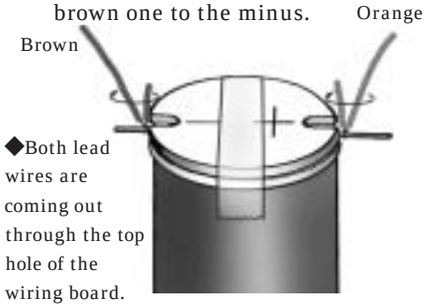
◆The longer leg is the plus terminal and the shorter one is the minus terminal.



4 Bend the legs of the LED to right and left. Cover with the upper light stopper as the plus terminal comes to the plus mark and the minus terminal to the minus mark. Fasten with a piece of a Scotch tape as shown in the figure.

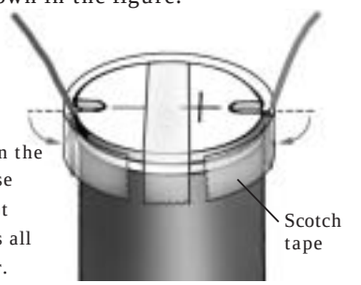


5 Connect the orange lead wire to the plus terminal of the LED and the brown one to the minus.



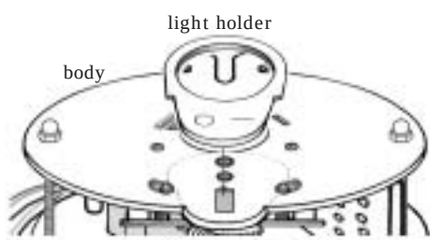
◆Both lead wires are coming out through the top hole of the wiring board.

6 Bend the legs of the LED down. Fasten with a piece of Scotch tape as shown in the figure.



◆Fasten the light case and light stoppers all together.

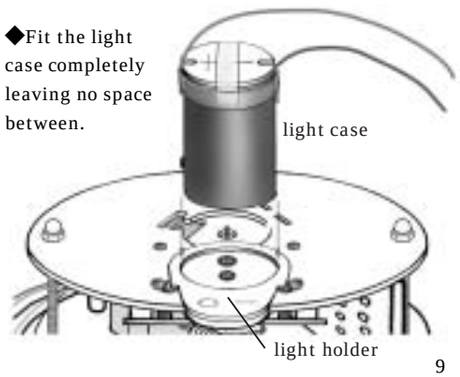
7 Set the light holder to the body.



◆Put the light holder on and off the body with the rubber magnet at the bottom.

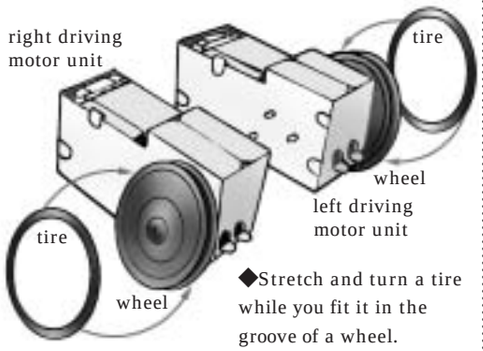
8 Fit the light case in the light holder.

◆Fit the light case completely leaving no space between.



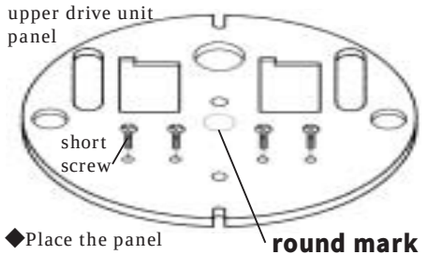
Lets Assemble the Drive Unit

1 Fit tires on the wheels of the driving motor units. Do in the same way to both units.



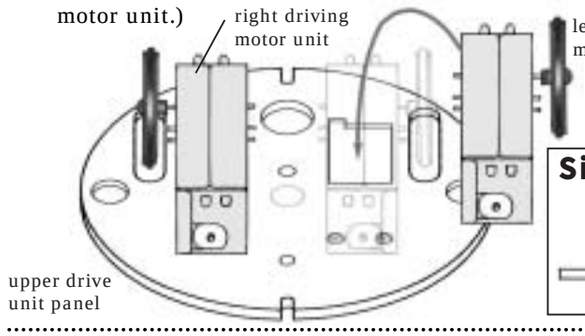
◆Stretch and turn a tire while you fit it in the groove of a wheel.

2 Place the upper drive unit panel as shown in the figure. Then, put four short screws in each of the four holes. (The panel is now upside down for easy handling.)



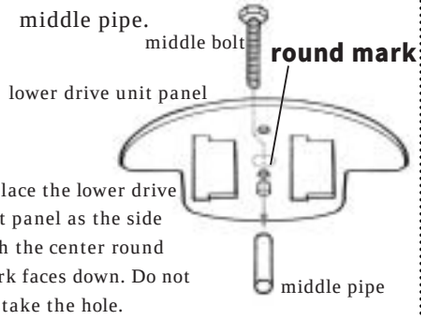
◆Place the panel as the side with the round mark faces up.

3 Fit the driving motor units (right and left) in the holes of the upper drive unit panel upside down. (Pay attention not to mistake right and left of the driving motor unit.)



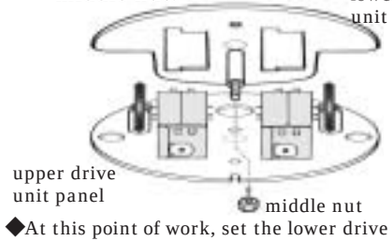
Side View

4 Insert a middle bolt in the lower drive unit panel as shown in the figure and then put it through the middle pipe.



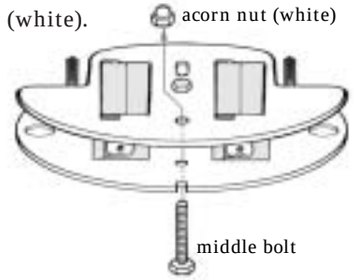
◆Place the lower drive unit panel as the side with the center round mark faces down. Do not mistake the hole.

5 Put the upper drive unit panel on the lower drive unit panel. Put the middle bolt into the hole of the lower drive panel and fasten with the middle nut.



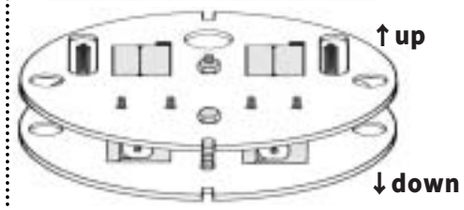
◆At this point of work, set the lower drive unit panel above and the upper drive unit below.

6 Fasten the upper and lower drive unit panels one more time with a middle bolt and the plastic acorn nut (white).



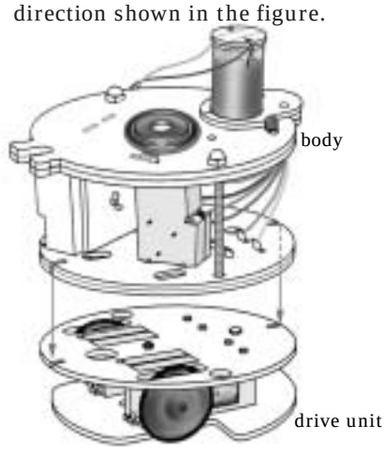
7 Now the drive unit is completed. Turn it upside down to be the right position. Two tires and the plastic acorn nut support this unit.

The inversion of the Figure ⑥

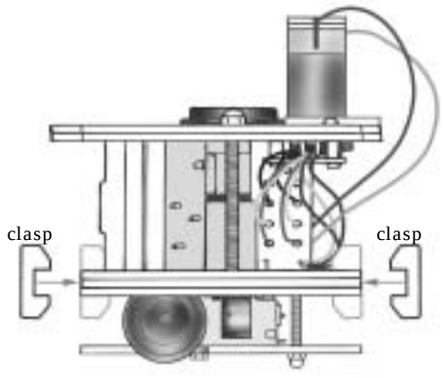


Let's Combine the Body with the Drive Unit

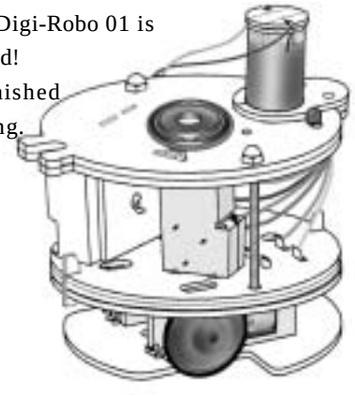
1 Put the body on the drive unit in the direction shown in the figure.



2 True up the notch of the panels in front and behind and fasten with clasps.



3 Now the Digi-Robo 01 is Completed! You've finished assembling.



Check!

1. Does the light case fit in the light holder closely?
(If light comes in from a gap, it may cause an error in operation.)
2.Are tires installed in the right position?

Let's Run the Robot!

First, try the program disk for diagnosis. With a felt-tip pen, the robot writes a track on a sheet of paper.

Things to be prepared

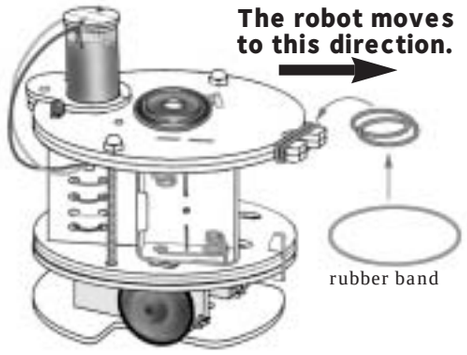
felt-tip pen (with a thin penholder)

rubber band

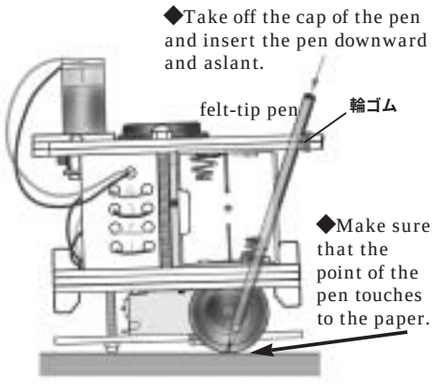
newspaper or some sheets of paper (as large as possible. As large as two-page spread newspaper is desirable.)

unused size C alkaline battery (2)

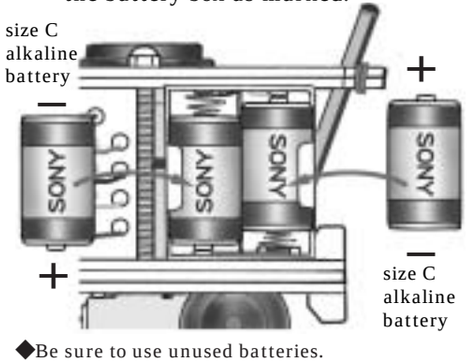
1 Put a rubber band around the projection of the body doubly. This projection with a rubber band is the front of the robot.



2 Put the felt-tip pen through upper and lower bodies from the rubber band to the ground.

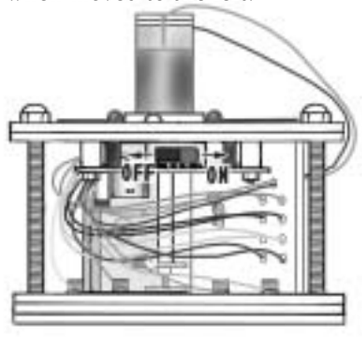


3 Set two unused size C batteries in the battery box as marked.

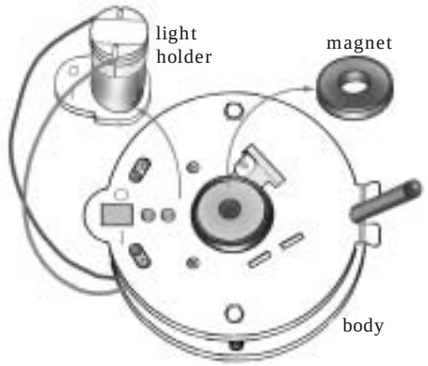


◆Be sure to use unused batteries. (Alkaline batteries are desirable.)

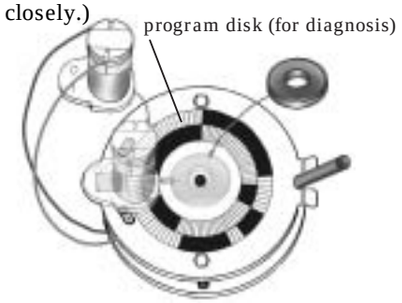
4 The switch is behind the baseboard. The switch is turned on when moved to the right and turned off when moved to the left.



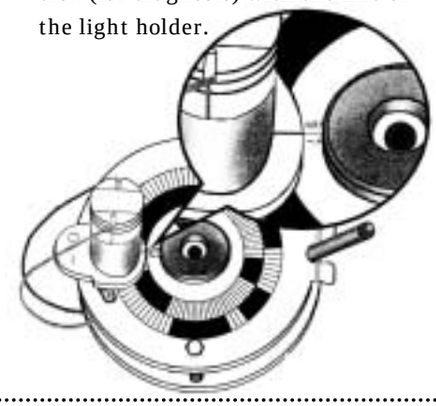
5 Take the magnet and the light holder off the body.



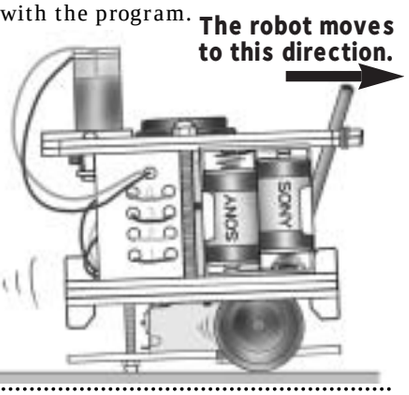
6 Put the program disk (for diagnosis) on the shaft of the turntable and fasten with the magnet. Then set the light holder. (Set it firmly and closely.)



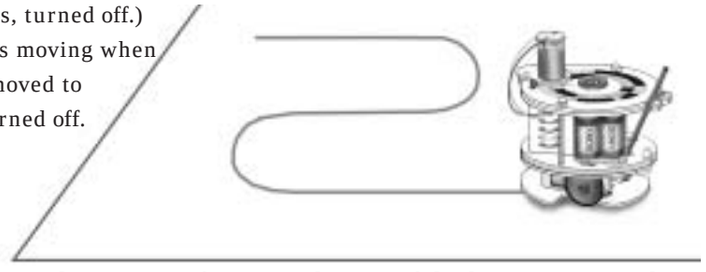
7 Align the start line of the program disk (for diagnosis) with the line of the light holder.



8 Turn the switch to the right and the robot begins to move in accordance with the program.



9 The robot moves drawing a trace on the paper turning on the red light of the LED in the direction of a turn. (When it goes straight, both lights are turned on and when stops, turned off.) The robot stops moving when the switch is moved to the left and turned off.



Note: Basically, a robot moves in accordance with the program. The distance to go straight and the angle to turn, however, may slightly vary depending on the condition of each robot.

●The Mechanism of how the Digi-Robo moves as Programmed

This robot controls the movement by reading light and shade that go through a program disk with optical sensors (CdS) and then transmitting the signals to the motors of right and left wheels. (The three motors that move the program disk and two wheels are linked.)

When you turn on the switch, the disk holder starts to rotate and the scales of the program disk pass under the light cover. (Figure 1)

The light cover is lit up inside by the LED on the top. When the degree of brightness doesn't change, motors keep moving at the same pace and both wheels also rotate at the same pace, and thus the robot keep going straight. (Figure 2)

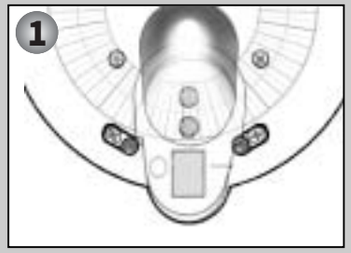
When the portion of the disk that is marked black passes under the light cover, the light is cut off.

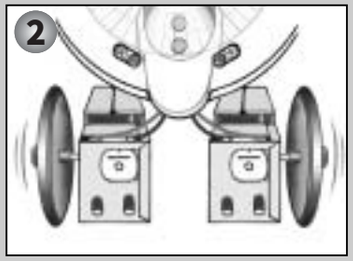
Then the sensors at the baseboard (CdS) sense that it became dark. (Figure 3)

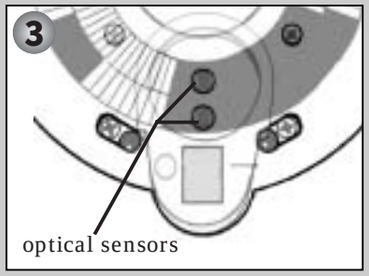
When the darkness is perceived, the motor at the right wheel stops when the dark part is inside, and that at the left wheel stops when the dark part is outside. The period of time when the motor stops is proportional to the period of time needed for the dark part to pass through the optical sensors (CdS). (Figure 4)

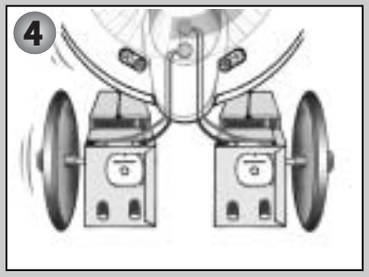
When the left wheel stops, the right wheel drives alone and then the robot turns to left, and when the right wheel stops, the left wheel drives alone and the robot turns to right. (If the dark part is both inside and outside, the robot stops moving while the dark part is passing under the sensor.)

When the dark part has passed, the motor starts moving again and the robot goes straight.









●When the robot doesn't go well

…Trouble Shooting and FAQ

●If it doesn't work, check the points below.

Problems	Measures to take
①The tires don't turn around.	See the figure 6 at page 8 and check the wiring again.
②program disk doesn't turn.	The motor unit (for the turntable) might not fit in the groove of the body panel (upper or lower). Fit it in again. Or, the bearing might be out of place. Check it too.
③When you designed a program disk for yourself, the dark parts of the program disk aren't sensed and skipped.	If the marks aren't dark enough, the sensor might sense the light. Be sure to use an indelible marker to mark program disks.
④The robot doesn't work as programmed.	See the inside of the light cover. Is the light of the LED on? If it's not, the terminals are connected wrong. Reverse the orange lead wire and the brown one.
⑤Program disks have run out.	Copy the program disk for copy at page 23 and use what you've copied.

●How to Program

Enjoy programming on a program disk.

*Things to be prepared: black indelible marker (for program disks), felt-tip pen (for trace), newspaper (or paper larger than A2), pencil (BB or darker)

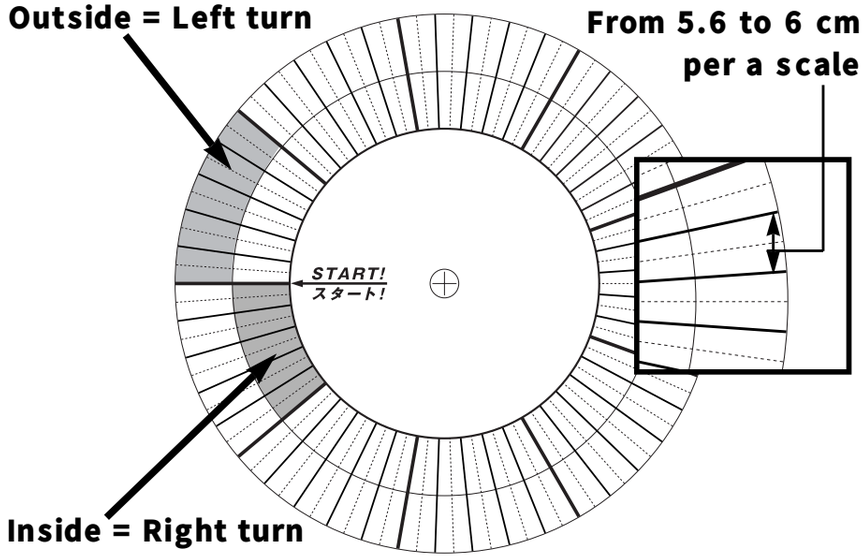
Note: Every robot has its own character. The distance to go straight and the angle to turn may slightly vary even if each robot runs by the same program. Find out the character of your robot and then adjust and apply at your discretion.

Basic Programming

★Understand the structure of a program disk.

A program disk consists of two circles, inside and outside. The inside circle controls right turns and the outside circle controls left turns. When both areas are blank, the robot goes straight and when both areas are marked, the robot stops. Each scale is put in units of 0.5 and there are 45 scales in total. The distance of the robot to move by one scale is from 5.6 cm to 6.0 cm, and the period of time of the robot to stop is approximately one second by one scale.

Be sure to use an indelible black marker to mark a program disk. (To avoid a mistake, mark the disk with a pencil first and then use a marker.)



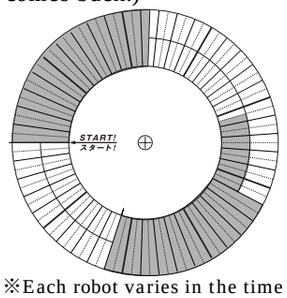
★Open Circuits

Let's program the robot to draw open circuits on spread newspaper with a pen in the holder. (Both circuits below are drawn per one rotation of a disk within the size of spread newspaper.)

1. U-turn

First, the robot goes straight and then stops. Next it makes a U-turn in a right-handed rotation and comes back.

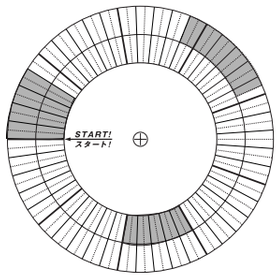
(It stops for a while after it comes back.)



※Each robot varies in the time of a stop.

2.Curve in S-shape

The robot goes straight, makes a right turn, goes straight again and makes a left turn. This series of movement makes an S curve. (The robot stops for a while after drawing.)

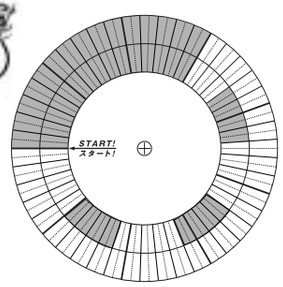


★Closed Circuits

Next, let's program the robot to draw closed circuits. If the starting point meets the end, your program is perfect. (Like open circuits, both circuits below are drawn per one turn of a disk within the size of spread newspaper.)

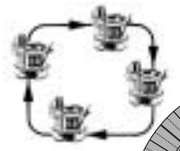
1. Triangle

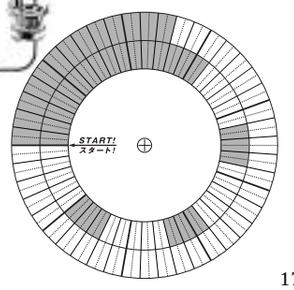
Let's program the robot to draw a triangle with round corners. (Three corners don't become acute. The robot stops for a while after drawing.)



2.Square

Let's program the robot to draw a square with round corners. (Four corners don't become right angles but curves. The robot stops for a while after drawing.)





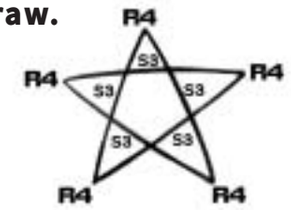
Applied Programming

Enjoy programming with your original ideas.

1. Think of the pattern you want to program.

Draw a pattern you want to program on a sheet of paper. Intricate patterns are not suitable for this robot to draw. Think of a pattern that is not too big. (Now we program a star-shape as an example.)

2. Give codes on the pattern you draw.

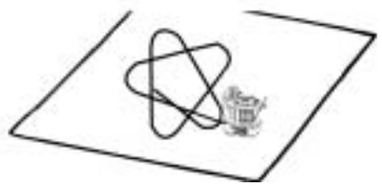


S, R and L stand for a straight line, a right turn and a left turn respectively. A figure expresses the number of scales. See “A Table of Scales for the Program Disk” on page 20 and 21 to estimate the distance or the angle of a turn.

3. Mark a program disk.

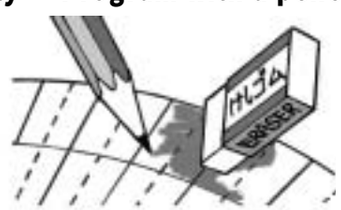
Mark a program disk referring to the codes you’ve written in the pattern. To avoid a mistake, you’d better mark with a pencil first before using a marker. Be sure to use an indelible black marker.

4. Set the program disk on the robot and turn on the switch.



If the robot doesn’t draw the pattern you’ve expected, adjust the number of scales you marked on the program disk.

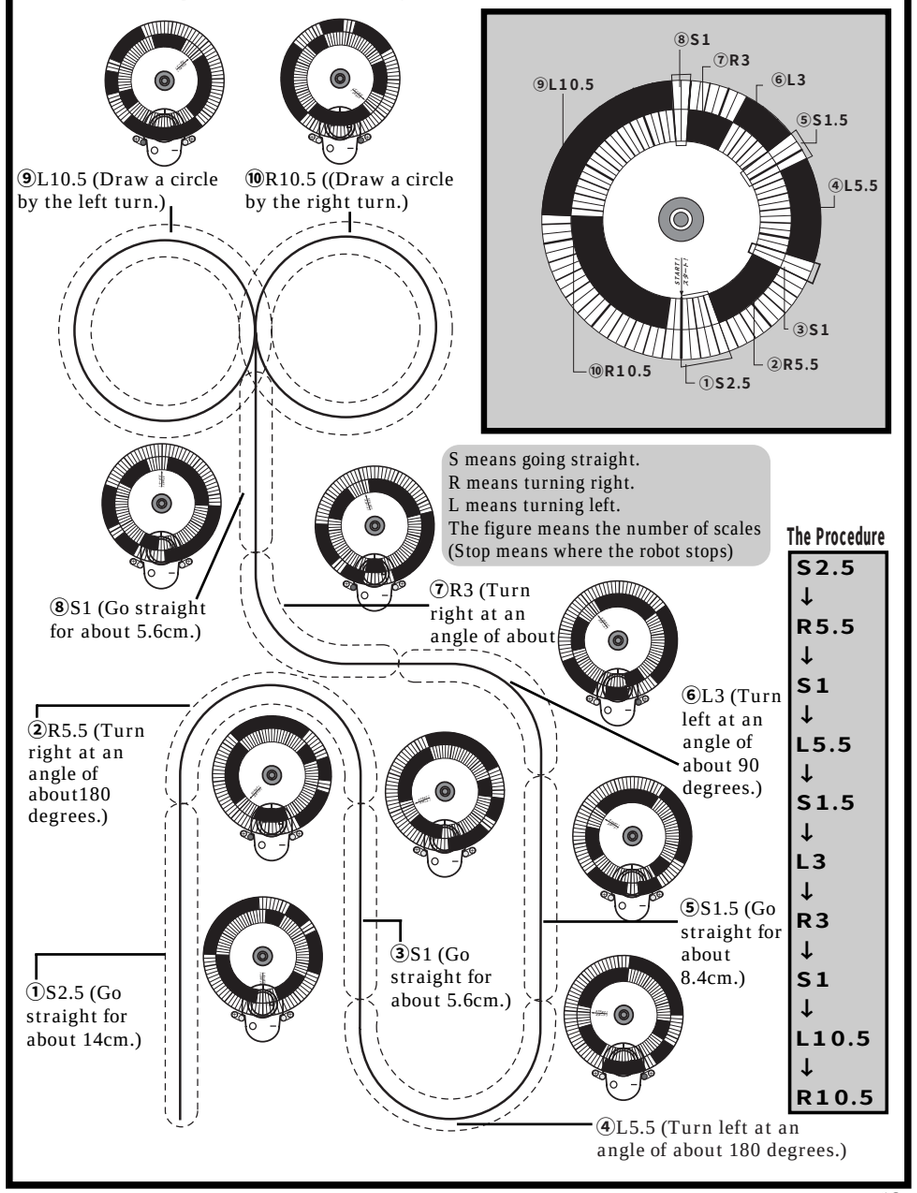
✱If you expect adjustments repeatedly ··· Program with a pencil.



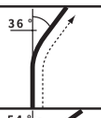
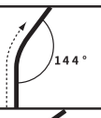
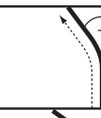
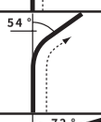
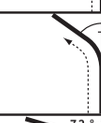
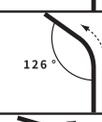
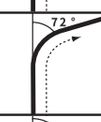
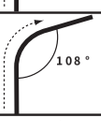
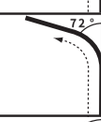
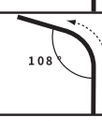
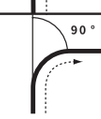
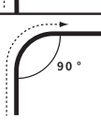
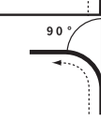
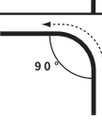
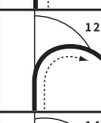
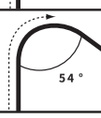
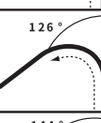
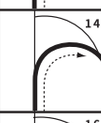
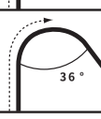
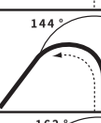
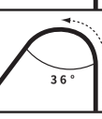
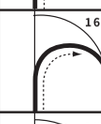
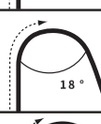
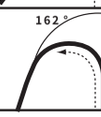
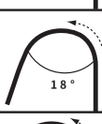
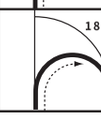
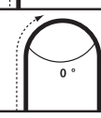
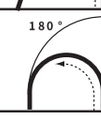
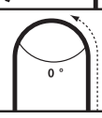
If you would like the robot to draw an intricate pattern that may require small adjustments, use a BB or darker pencil instead of an indelible black marker. You can erase and add the marks when making fine adjustments.

Find out the Character of your Robot by Running it with a Disk for Diagnosis

Run the robot with the program disk (for diagnosis). Within one turn of the program disk, the robot performs basic actions such as going straight, making a U-turn, making a right-angled turn to the right and to the left, and drawing a circle. Observe these actions and diagnose the character of your robot.



●A Table of Scales for the Program Disk●

The Number of Scales	Going Straight S	Right Turn R (Inside)				Left Turn L (Outside)			
	Distance (cm)	(Exterior) Angle	Image of the (Exterior) Angle	Image of the (Interior) Angle	(Interior) Angle	(Exterior) Angle	Image of the (Exterior) Angle	Image of the (Interior) Angle	(Interior) Angle
0.5	2.8								
1	5.6								
1.5	8.4	36 °			144 °	36 °			144 °
2	11.2	54 °			126 °	54 °			126 °
2.5	14.0	72 °			108 °	72 °			108 °
3	16.8	90 °			90 °	90 °			90 °
3.5	19.6	108 °			72 °	108 °			72 °
4	22.4	126 °			54 °	126 °			54 °
4.5	25.2	144 °			36 °	144 °			36 °
5	28.0	162 °			18 °	162 °			18 °
5.5	30.8	180 °			0 °	180 °			0 °
10.5	58.8	360 °			360 °	360 °			360 °

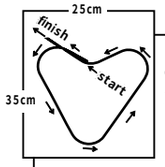
Note: Every robot has its own character. The distance to go straight and the angle to turn may slightly vary even if each robot is programmed in accordance with this table. Find out the character of your robot and make fine adjustment by changing the number of the scales you marks.

S means going straight.
R means turning right.
L means turning left.
The figure means the number of scales
(Stop means the point the robot stops)

Examples of Programs with a Message

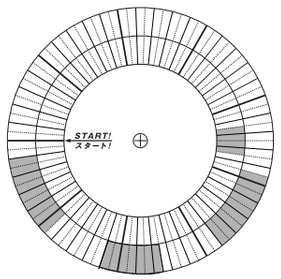
Here are some examples of patterns with a message. Think freely and program with your original ideas. (The measurements are approximate.)

Heart

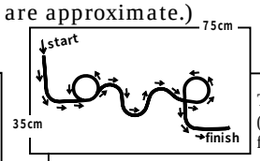


The robot moves counterclockwise. Remove it when the line crosses.

S1 ↓ ↓ S3.5 L4.5 ↓ ↓ L4.5 S3.5 ↓ ↓ S1 L3.5 ↓ ↓ R2

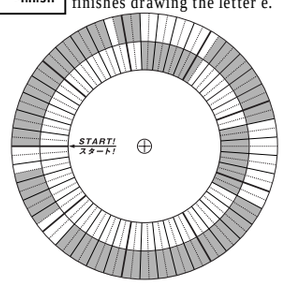


Love

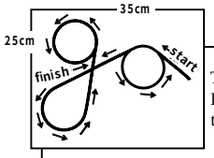


The robot starts from the left (L). Remove it when it finishes drawing the letter e.

S1.5 ↓ ↓ R4.5 L3 ↓ ↓ L1.5 S1.5 ↓ ↓ S0.5 L13 ↓ ↓ L9 R5 ↓ ↓ S1.5 L5.5 ↓ ↓ L3 ↓ S1.5

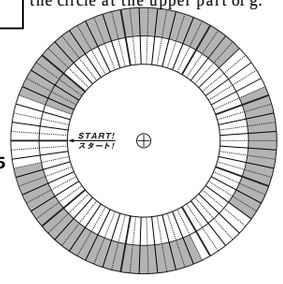


go

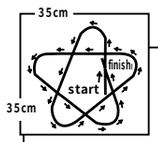


The robot starts from the right (o). It stops when it finishes drawing the circle at the upper part of g.

S1.5 ↓ ↓ S2.5 L13 ↓ ↓ L12 S3.5 ↓ ↓ Stop2.5 L7.5 ↓

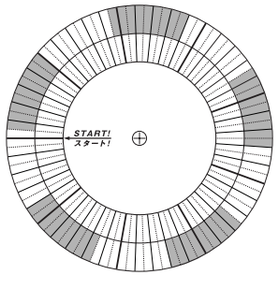


Star

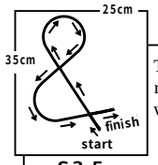


Remove the robot when the line crosses at the end.

S4 ↓ ↓ S4.5 L4.5 ↓ ↓ L4.5 S4.5 ↓ ↓ S4.5 L4.5 ↓ ↓ L4.5 S4.5 ↓ ↓ S0.5 L4.5 ↓

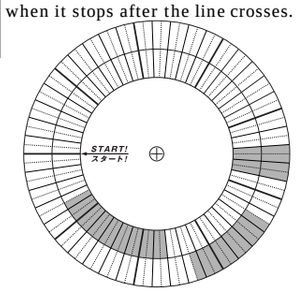


&



The robot moves from the lower right to the upper left. Remove it when it stops after the line crosses.

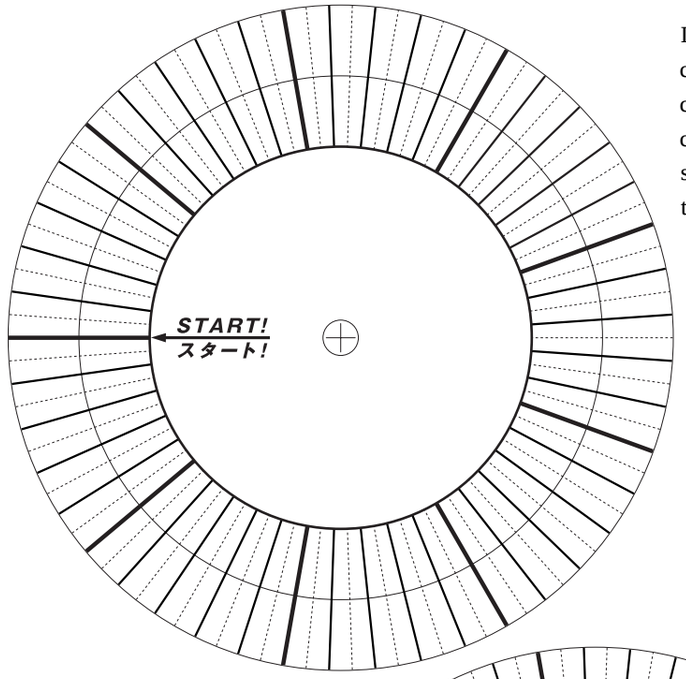
S3.5 ↓ R8.5 ↓ S1.5 ↓ L5 ↓ S2.5 ↓ Stop2.0



Note: Every robot has its own character. Fine adjustment might be needed.

S means going straight.
R means turning right.
L means turning left.
The figure means the number of scales
(Stop means the point the robot stops)

Program Disk (for Copy)



If it is difficult to cut out the center circle, cut the center cross and insert the shaft of the turntable.