TJ Robot WorkBook

By
Keith L. Doty
Scott Jantz
Aamir Qaiyumi

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MANIFESTO

Mekatronix™ espouses the view that the personal autonomous agent will usher in a whole new industry, much like the personal computer industry before it, if modeled on the same beginning principles:

- Low cost,
- Wide availability,
- Open architecture,
- An open, enthusiastic, dynamic community of users sharing information.

Our corporate goal is to help create this new, exciting industry!

TALRIK JUNIOR, affectionately known as TJ, is an excellent robot for introducing you to the exciting area of programmable, autonomous, mobile robots. *Programmable* means that TJ has a computer on board that allows you to change its behaviors. *Autonomous* indicates that TJ can act on its own without being directly controlled by a person. *Mobile*, of course, tells us that TJ can move around!

A completed TJ has a 7-inch radius and 3.5 inch height. He is constructed from beautiful, 5-ply model aircraft plywood and rides on wheels and a rear skid. Two gearhead motors mounted underneath the platform drive the wheels, one motor per wheel. The computer on TJ serves as the robot brain. TJ has very little memory: 256 bytes of RAM and 2 KBytes of EEPROM.

Most of TJ's electronics fit under a removable top plate that hinges in front and locks down in the back with a wooden key. TJ possess two IR detectors and two IR emitter headlights in the front. An IR emitter taillight mounts in the back underneath the plate. A plastic bumper encircles TJ's waist. Four contact switches, three in front and one in back, allow TJ to detect front or back collisions.

You can add more sensors to TJ to help him detect more about his environment. Programming TJ requires additional hardware and a personal computer. A serial communication link allows the user to upload and download TJ data and programs from a PC. You can program TJ with a programming language called C or in the Assembly Language of the microprocessor.

Biology of Robots

You need:
A TJ Robot
A Pencil
This Worksheet

INTRODUCTION

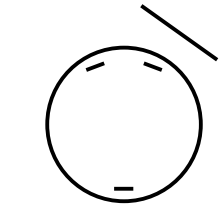
Our eyes are detectors which are designed to detect visible light (or visible radiation). Visible light is one of the types of radiation that can penetrate the Earth's atmosphere and be detected on the Earth's surface. There are also forms of light (or radiation) which we cannot see. Actually we can only see a very small part of the entire spectrum of radiation called the electromagnetic spectrum. The entire spectrum includes gamma rays, X-rays, ultraviolet, visible, infrared, microwaves, and radio waves. The only difference between these different types of radiation is their wavelength, or frequency. In addition to visible light, radio and some infrared radiation can also penetrate the Earth's atmosphere. Our atmosphere blocks out the rest.

TJ uses infrared (IR) radiation to see. The IR light is emitted from each of the "headlights" on TJ's head. There are detectors, or "eyes", under the head that can see the IR light and tell TJ's brain (the computer) how bright the light is. The infrared light reflects off objects and returns to the detectors. If an object is closer to TJ, the reflected light is brighter, and if the object is further away from TJ, the light is dimmer.

Because this is a different form of radiation from what we can see, TJ's world is different from ours. While we see the colors red, orange, yellow, green, blue, and black, TJ sees only shades of black, white and gray. Dark colors are hard for TJ to see because the IR light is not reflected from dark colors as well as from light colors. Since TJ can see lighter colors better than dark colors, it will turn away from the lighter colored objects sooner than it will for darker ones.

TJ EXPERIMENTS:

Experiment 1

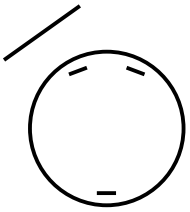


If the robot bumps into something, what does it do?

_____

When you hold the barrier slightly to the **right** of the robot, what does it do? Approximately how close to the paper does TJ get before it does this?

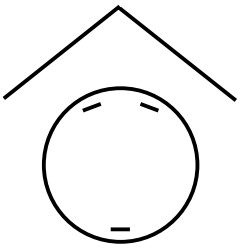
_____



When you hold the barrier slightly to the **left** of the robot, what does it do? Approximately how close to the paper does TJ get before it does this?

_____

_____



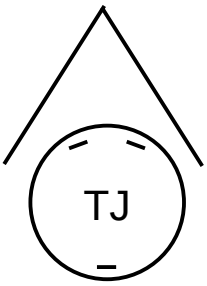
Open the barrier and hold it in front of TJ as shown. What does TJ do?

_____

_____

This situation is called a Braitenburg Trap. Try changing the angle of the corner and record what happens.

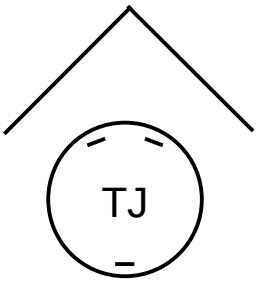
Try these configurations and record what happens:



Acute Angle

_____

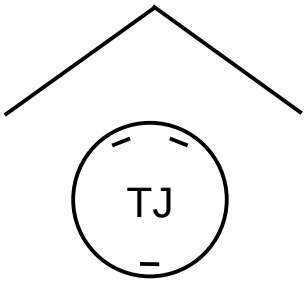
_____



Right Angle

_____

_____

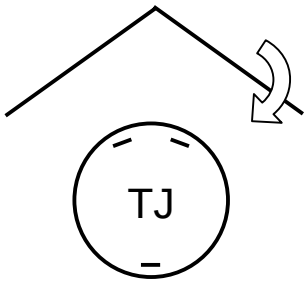


Obtuse Angle

_____

_____

Slide one side of the TJ barrier toward TJ while holding the other side still. What does TJ do?



_____
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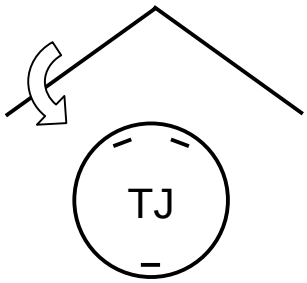
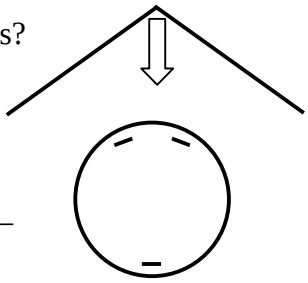


_____
_____

Now move the whole barrier forward toward the TJ robot. What happens?

_____



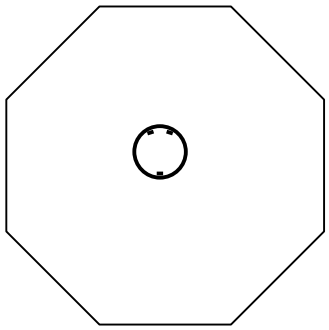
If you put two TJs facing each other, how do they react?

_____

When TJ sees something to the **left**, it turns _____.
When TJ sees something to the **right**, it turns _____.

Experiment 2

Get together with other groups and build an arena for your TJs. What does the TJ do?



_____

_____

Which way does TJ circle the arena?

_____

What happens if you block TJ's path while it is circling?

_____

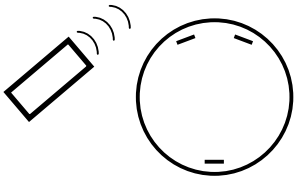
Next, leave an opening in the arena so you can see how wide the hole has to be before TJ can escape. How wide does the hole have to be? _____

Experiment 3

Aim the remote at the floor a little in front of the robot and hold down a button. What happens?

_____

_____



If you aim the remote control directly at the robot's eyes and hold down a button, what does TJ do?

_____

From approximately how far away can you still affect the robot?

_____

Experiment 4

Aim the remote control in front and to the left and right of TJ. What does TJ do?
Aim to the Left: _____ Aim to the Right: _____

Try the same things using a TJ in place of the remote control. What happens?

_____

Turn the TJ on and hold it in front of the camera. What do you see?

_____

Hold the remote control in front of the camera and hold down a button. What do you see?

_____

What do TJ and the remote control have in common?

_____

Experiment 5

Go to your robot teachers to reprogram your robot.

Plug the 6-wire cable into TJ's head. Switch the robot to **Download** mode, and turn the power on. Watch the lights on the communications board. One of them should flash every time you push the **RESET** button. If this does not happen, then the cable is plugged in backwards on the robot. Pull it out, turn it around and plug it in, then try again.

When the robot is plugged in correctly, you can try some of the experiments your robot teachers will give you.

What happens to the lights on the communications board while the TJ is being programmed?

What do these lights mean? (HINT: Ask your robot teachers.)

GLOSSARY

Angle

Acute Angle – Angle with measure less than 90°.
Obtuse Angle – Angle with measure greater than 90°.
Right Angle – Angle with measure 90°.

Braitenburg Trap

Oscillations generated during collision avoidance when the robot sensor input on the right and left dictate opposite turning motion simultaneously. The net result is the robot cannot "decide" which way to move and just rapidly vibrates alternately to the left and right.

Infrared Light

invisible electromagnetic radiation that has a longer wavelength than visible light and is detected most often by its heating effect

RAM

Random Access Memory. A computer can read and write information to this type of memory. When electrical power is removed from a RAM, the contents of memory are lost.

EEPROM

Electrically Erasable Programmable Read-Only-Memory. Usually, the computer only reads this memory. When electrical power is removed from an EEPROM, the contents of memory do not change. Special electrical signals must be used to write to this memory and the writing process is very slow compared to reading.