Rescue Course
Conceptual level

by

Peter van Lith

James Caska

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Introduction

This introductory Rescue Course is for YOU, students of 9 years old and older.

Along with the Basic Course, it takes you into the wonderful world of small robots, that is, little machines that you can give instructions to do things that you decide, like moving forward, moving backward, turning, etc.

This Rescue Course teaches you how to make a robot play games all by itself.

Course outline

This Rescue Course will entertain you while you start learning about robots through a number of game-like exercises that will allow your robot to rescue a "victim" or clear a dangerous object lying inside a swamp.

It will describe the rescue game, introduce your robot and teach you to program it with instructions using an entertaining, game-like, computer tool called roboPAL programming environment.

The Course also gives you information about the sensors that you need to allow your robot to detect where it is.

The sensors are little devices the robot uses to interact with its surroundings, like you use your eyes, nose, etc.

The Rescue Course consists of a number of lessons, each treating a separate topic:

Introduction to Rescue

What is the Rescue mission

A container with an unknown substance has been found in a swamp. Your mission is to make your robot go to the swamp as quickly as possible. Once the robot arrives at the swamp, it must search for the containers and push it out to the shore, where it will be picked up by rescue workers.

We are using a robot because we do not know if the content of the container is dangerous. The people who will pick up the container later on have special equipment that protects them while they investigate the container.
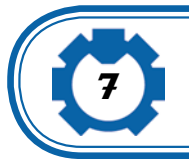
The rescue field has a winding road that your robot has to follow to reach the swamp. To save time you may choose the yellow shortcut, but in this case your robot has to detect the color difference.

Take care with the road after that. Some of the bends in the road are difficult and your robot may get out of it and get lost. Once your robot reaches the swamp it must search for the container (which is a soft drink can wrapped with aluminum foil).

Once your robot has found the container, it must be able to push it out to the shore.

Using roboPAL

You will be using the roboPAL software program to perform your mission. The robot will already be assembled for you and the roboPAL program is used to program the robot.

RoboPAL also contains a simulator that shows you on the screen of your computer what the real robot will do when it runs your program. So you may test your mission before actually doing it for real and

even without a robot.

If the robot on your computer does what you wanted it to do, then you are ready to load the program onto the robot's computer. You will then see the real robot following your instructions.

You will notice differences between the performance of the simulator and the real robot because a simulator is much simpler than the real robot and cannot react to things like changing lights, shadows, batteries that are running low and other things that happen when you use a real robot.

You will get a short introduction on how to use roboPAL from your teacher and if you have any questions, please ask your teacher or read the instructions of the roboPAL program in the roboPAL manual.

The RDS-X01 robot
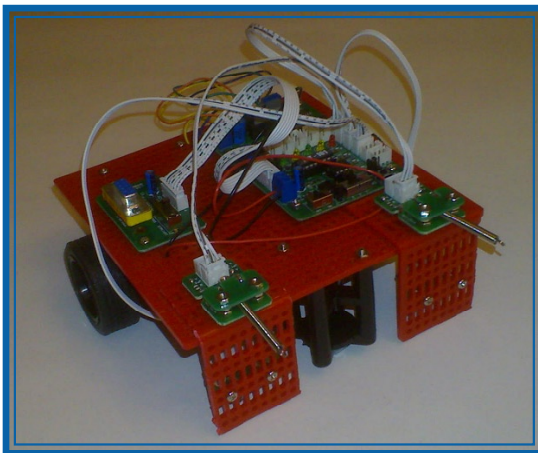
You do not have to assemble the robot. It has already been done for you.
The robot has a small computer on top that may be connected to your computer using a cable.
When you make your program with roboPAL you can send this program to the robot and then this will do the same thing as you have seen in the simulator.

The robot has two touch sensors in front that help it to detect obstacles. We also use these sensors to start the robot.

The robot also has two infrared sensors that detect color differences on the floor, using them to follow the road on the rescue field.
 It has some LED lamps, a small speaker and a so-called DIP switch used to tell the robot which program it needs to execute.

More information about the robot can be found in the documentation provided with the robot.

If you do not understand how to use the robot please ask your teacher.

The lessons

Once you have your computer with roboPAL installed on it, you are ready to start with the lessons and exercises in this Rescue Course.

In each lesson you will learn an important new step and once you have finished all lessons, you will be able to program your robot to perform the Rescue Mission. You will also be ready to enter a competition with your classmates.

Who will be the first to rescue the container?

In every lesson you will find the same topics, as follows:

● What you need, telling you the things that you need to prepare to follow the lesson.

● What you will learn, explaining the most important things you will learn. In every lesson, we will try to let you discover new things that you will find fun to work with.

● The assignment. Every lesson is set up to make a small program that does something new that you need to fulfill the mission. After reading the instructions you are off on your own.

● Background information, providing additional reading if you are interested in more detailed information. It may also be helpful to read this information if your robot does not do what you expected,

Normally when things go wrong you learn the most because you have to find out what you did wrong.

Robots do exactly what you tell them to do, they do not know if what you tell them is good or complete and you will find out that when things do not work, it is almost always because of something incorrect you have put in the program.

Often, you think that you have told the robot exactly what it needs to, do but when the robot does not work, the best thing to do is to check if what you told it is really fine for what you wish your robot to do. Sometimes these little misunderstandings are very hard to find.

Lesson 1. The first line follower

What you will need
In this first lesson you will start with a field that will be used during the first two lessons only.

It is a square and is part of a new version of the rescue mission that you will also see in later lessons. If you want your RDS-X01 robot to do this lesson, you need to make a field that looks like this one. But in this first lesson it is easier to use the roboPAL simulator, without having the RDS-X01 robot run the program as well.

What you will learn
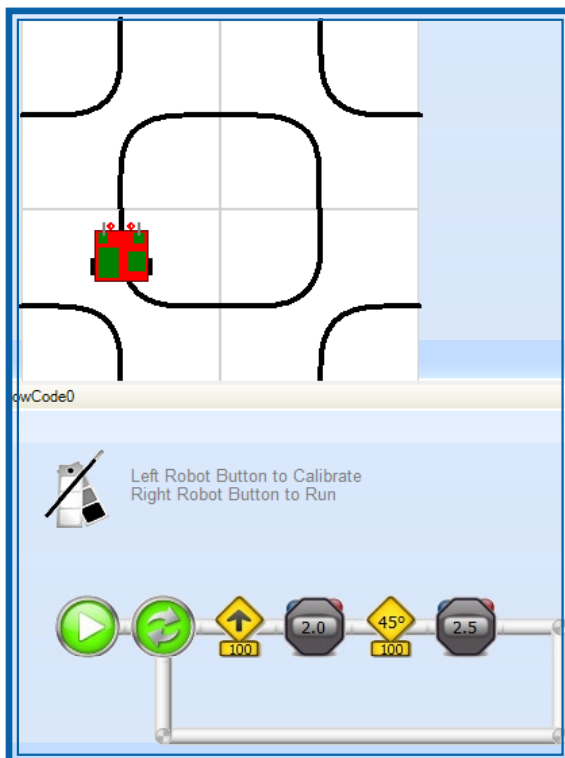
You will learn about line followers. A line follower is a small program that allows your robot to follow a line by itself, using its sensors. You will also learn that following a line may be very hard to do.

With computers and especially with robots many things can go wrong. In most cases that occurs when unexpected things happen, like something not being in exactly the place where the robot "thought" it would be. This is typical for robots.

The assignment
Let your robot follow the rounded square.
If you let the robot first drive forward for 1 second and then make a turn of half of a quarter of a circle (this is called 45 degrees) for 1 second, you will see that it will follow the square very well.
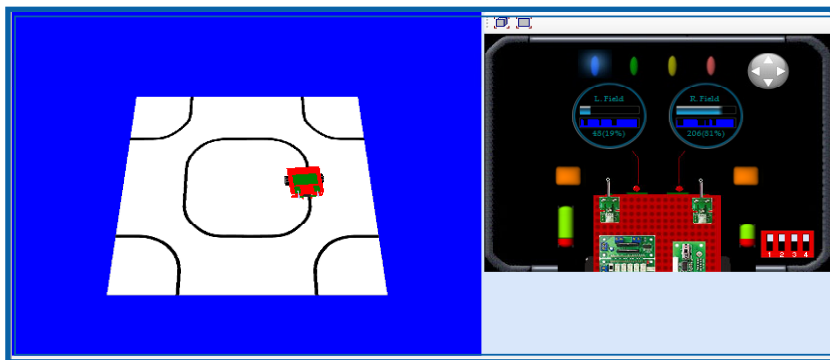But look out! if you put your robot in the wrong place, things will go

very wrong and the robot will not even notice it.
How are you going to solve this?
When you start the simulator, it seems that the robot is not going to start.

The Calibrate icon you see here is included to let the robot detect by itself where the line is. We will tell you more about this in the next lessons.

You have to start the robot by letting the right sensor make contact. It will then start moving automatically.

To start the simulator you first press the small run button.
Then you will see this screen The buttons of the robot are on the right-hand side.
Press the yellow button shown by the arrow and see the robot move.

Background information
Most robots that work in factories such as the ones that make cars are programmed in the same way as this robot.

If they need to put in a new door and the car is not in the right position, the door will not fit in. So, the robots need to be very precise and the things they need to put into a car must always be in the exact position.

If you try to we do something like this, you will immediately notice that the door needs to be moved a little to get the correct position. Many robots cannot do this, so can we make a better robot, that is not so stupid?

Lesson 2. A better line follower

What you need

In this lesson you can use the same field as in the previous lesson. You may also use the circle field. You will use the light sensors, so they need to be attached, looking down towards the field.

What you will learn
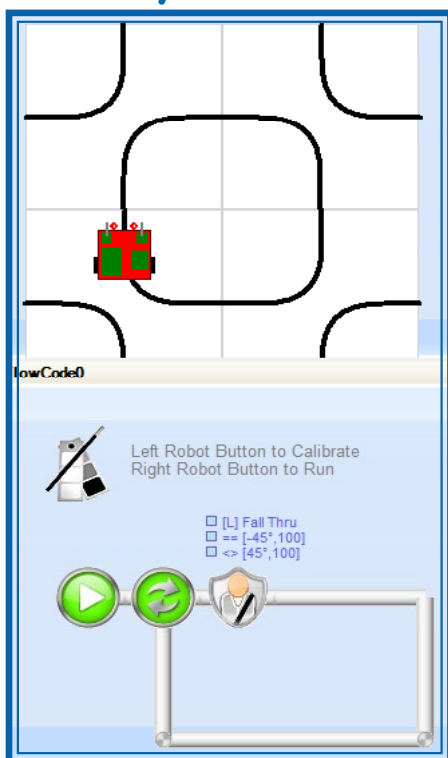
Following a line or a pattern by describing when to make a turn is not a good idea, because if you do not place the robot in the exact location, it will not follow the line but some other pattern.

So you are going to use the sensors to let the robot detect the black line by itself and the robot will use this detection to follow the line.

The assignment

You will write a program that follows the line using the black-and-white line-follower. You will find out how to set the properties of the line follower to make it move faster and smoother.

A line follower robot uses sensors to detect where the line is.
Notice how the robot follows the line.

Here too, you have to start the robot by pressing the right contact sensor.

Notice how the line follower in the program will only follow a small portion of the line and then stop. So you will have to make a loop back to the beginning for the line follower to continue.

Background information

Following a line is more difficult than you may think. When you (not your robot) will try to follow a line you will probably concentrate on the middle of the line and try to stay there.

But with a sensor this is not possible.

The middle of the line is black and since the rest of the line is also black it is hard to tell where the middle is. So instead we look at the edges of the line.

You can use one sensor and concentrate on one edge of the line but you can also use two sensors and concentrate on both edges.

If you do not make any changes to the line follower, it will automatically use only the left sensor, which is good enough for now.

Exercise

Try to find out what the line follower does and describe what you think is happening.
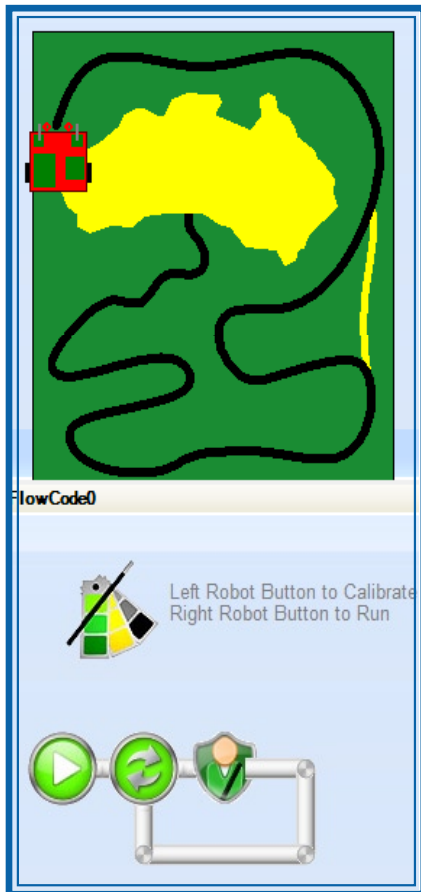
Try also to get the robot to make mistakes.

If you think you know how it works, try to fool the robot's sensors so it will not work any more

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Lesson 3. Rescue autocalibration

What you need

You will now need a rescue field. This field has three different colors that need to be detected by the reflection sensors, so these sensors need to be connected.

What you will learn

Detecting the difference between black and white is not so hard, because there is such a large difference. But when we use a colored field, detecting colors is much more difficult. You will learn about calibration of your robot, so that it can recognize how the colors on the field look like.

The assignment

Most of the work in this assignment will be done by your robot. Because it needs to know how the colors Yellow, Green and Black look like, you have to tell it where these colors are.

The robot has a small program, called the calibration program that will detect the colors and remember them.

Then when you start the robot, it will use the color settings that it registered during the calibration.

FlowCode0

Left Robot Button to Calibrate
Right Robot Button to Run

Do the following exercise:

1.   Place the robot on the yellow field.

2.   Press the left touch sensor to start the calibration procedure. The robot will move forward and register the color values as it moves over the field. It will stop once it has registered the black line.

3.   Put your robot back at the beginning of the road and now press the right button to start your program. It will follow the line until you stop the program.

Notice the difference with the previous program. You are using the black-on-green line follower. When you run the program, it will follow the line just as with the previous example.

Background information
Once the robot has been calibrated, you only need to do it again when something changes, for instance, if you move to a new field or when the light in the room changes.

Calibration is very important because it tells the robot what colors to look for when it is following the line. When a robot has not been calibrated correctly, it will start making mistakes and will miss the line.

Exercises
If you put the robot on the wrong color it will calibrate the wrong way and will not work any more. Try out various ways of calibrating.

Take into account the situation of the light around the robot.

The presence of shadows or when you hold your hand over the robot's sensors the values may change. Try to see if you can see any differences.

Lesson 4. The rescue line follower

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Left Robot Button to Calibrate
Right Robot Button to Run
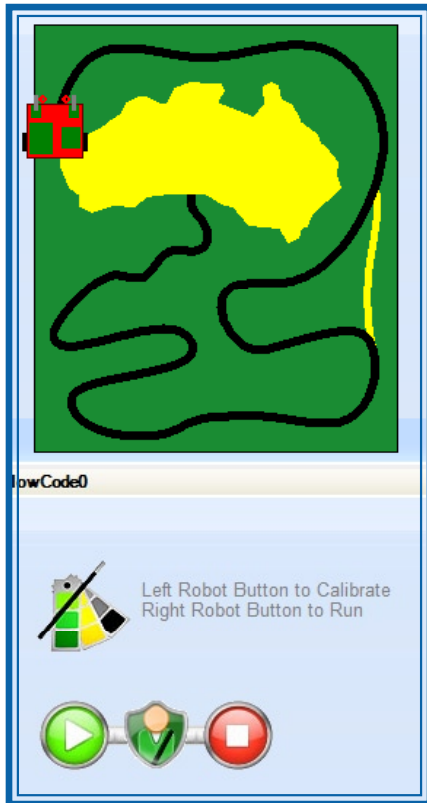
What you need
You will now start using the property window of the line follower control. The rest stays exactly the same.

What you will learn
You will find out the difference between using a single sensor and two sensors.
You will find out how you can modify the behavior of the line follower and also how you can test whether the robot has reached a certain point.

The assignment
The line follower has a number of options that you can use to make it move faster or to follow different colors. Also it has a stop condition. Your mission is now to follow the line until you detect the yellow line.
Then you will experiment with different speeds and angles. Now make a program that follows the line, but this time you should eliminate the loop. The line follower will continue to work until it detects the yellow line.

Background information

You control the behavior of the line follower through defining its properties.

Put the cursor on the line follower control and you will see the property sheet for this control showing the following properties:

● Sensor Configuration. You can use one or two sensors. The two sensors configuration is the fastest.

● Stop Condition. When you specify yellow, the program will continue to follow the line until it detects a yellow line. If you do not specify a stop condition, it will stop immediately and you will have to loop the program back to the beginning, like you did in the previous examples.

● Left/right angle specifies how big a turn the robot makes when it detects the line.

● Left/right Speed indicates how fast the robot turns when it detects the line.

● Left/right Acceleration specifies how fast the robot makes the turn away from the black line.

Exercises

Now experiment with these settings. First try to run with a single sensor and notice what happens. You can use either the left or the right sensor. If you do not specify a stop color, the line follower will stop immediately and you will have to put in a loop. This is not done in this example however.

| Properties	
Sensor Configuration	2 - Left and Right Sensors
Stop Condition	Fall Thru
Left Deflection Angle	-30 - veer left
Left Speed	100 - Top Speed
Left Acceleration	0
Right Deflection Angle	30 - veer right
Right Speed	100 - Top Speed
Right Acceleration	0
display	false

Lesson 5. A faster line follower

What you will learn

Now that your robot has found the yellow line, we want it to follow the shortcut and then wait for the black line again and follow that one.

We want the robot to follow the line until it reaches the swamp area.

You will learn how to combine several line followers so that you can now follow the entire road. This almost completes the mission. It is up to you now to make the robot go as fast as possible.

The assignment
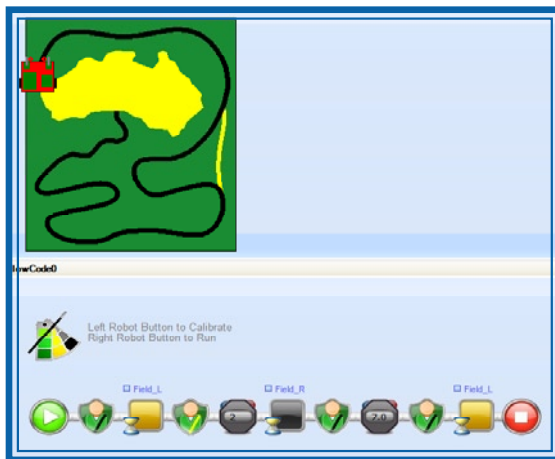
Modify your program so that it starts to follow the yellow line and, then, when it detects the black line, start following it until it reaches the swamp area.

Background information

Notice how you are using the black line follower with a yellow stop condition. Notice that here you do not use the stop condition of the line follower itself.

Instead you start the line follower and like in the example where your robot drives forward for 4 seconds, the line follower will continue to follow the line until it detects the yellow color.

After that it will start following the yellow line for at least 2 seconds. Why do we do this?

As long as the robot is moving, it may still see the black line and will stop immediately. So it only starts looking for the black line after 2 seconds.

Then you will see that it follows the line for 7 seconds at high speed and slows down when it arrives at the winding road so it does not get lost.

This continues until the yellow swamp is detected.

All we have to do now is to find the container.

ASIMO humanoid robot © by Honda Motors LTD

Lesson 6. Clear the rescue field

What you need
For this last exercise you will need some cups and place them on the rescue field.

What you will learn
You will learn how the robot can move back and forth over the yellow swamp area and push all cups outside the field.

The assignment
Place about 6 cups at various positions in the yellow field.
Write a program that makes the robot move forward until it sees the green field.
Then let it move backward again until it sees yellow and make a small turn. Repeat this for a couple of times so the robot covers the entire field.
While the robot moves it will push all cups out of the swamp area.

Background information
Notice how the robot moves back and forth and the timer is used to determine how far the robot moves backward and how big is the turn the robot makes.

Exercises

Experiment with the speed, the time the robot moves backward, and the turn angle of the robot. Make sure it covers the entire field and does so as quickly as possible. You can now use this program to finish the rescue mission.

Add this part of the program to the end of the previous program and let it run the entire mission.

Challenge your classmates to a competition.

Remember, the fastest time so far has been 36 seconds. Can you beat it?

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