fischertechnik ROBOTICS

Discovery Set

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Welcome to the fischertechnik World of ROBOTICS

Hello!

We are happy you have chosen the "ROBOTICS TXT Discovery Set" construction set from fischertechnik. Because with this construction set you can conduct many interesting experiments and solve exciting tasks.

Read this digital booklet and try the experiments and tasks, to learn step-by-step how you can control and program simple as well as complicated machines and robots using the ROBOTICS TXT Controller from fischertechnik.

Learning is a process of building things up from a foundation and it is not possible to start with the most difficult things right away, even though they may be a little bit more interesting than the more simple tasks. This is why we have structured the experiments and tasks in this booklet so that you learn something different with every new task and can then use this as the basis for the next task.

So don’t worry, we will start with small things and then work together to progress to the big robots.

We hope you have a lot of fun and success now experimenting with your ROBOTICS TXT Discovery Set.

Your team from
Some General Information

Before we really get started with the construction set, you still need to know a few things. Even though the components we will work with are very robust, if you do not handle them properly, they can be damaged under certain circumstances.

Electricity

As you certainly know, a lot of the components in the ROBOTICS TXT Discovery Set use electric power. And you know it is necessary to be particularly careful not to make any mistakes when working with electrical components. That is why you should always read the assembly instructions very carefully when wiring the electrical components.

Never connect the positive and negative poles directly to one another to prevent a short-circuit. This can damage the ROBOTICS TXT Controller or the rechargeable battery.

The subjects of electricity and electronics are just as interesting as robotics (which is what this construction set is about) and there is a construction set from fischertechnik, which deals specifically with these subjects. If you are interested in this, you will also have just as much fun with our "PROFI Electronics" construction set as with the ROBOTICS TXT Discovery Set.

About this Activity Booklet

This PDF activity booklet has a number of functions, which are not present in the printed booklet and which may already be familiar to you from the Internet.

- Links within the Booklet

When something is mentioned somewhere in the text, which is explained in more detail at another point in this booklet (for example, components), the text appears in dark blue and underlined. You can click on the text to move automatically to the page containing the explanation. This is called a "cross reference."
● Background Infos

In some cases in this booklet, there are terms or foreign words, which may require explanation. These terms are displayed in **green and underlined**. If you touch the text with the mouse pointer, a window appears with an explanation.

● Link Outside of this Booklet

A few links require an Internet connection (for example, the fischertechnik web site), or an installed ROBO Pro (for connection to the ROBO Pro online help). These terms are displayed in **light blue and underlined**.

● Pictures

A picture is worth a 1000 words. You have certainly heard this sentence before. And because this certainly contains a lot of truth, you can display a picture by touching the words in **brown and underlined** to see a picture showing what is meant in the text.

● The ROBO Pro Icon

This is always located in the vicinity of tasks. This makes sense, because as soon as you click on it, a suitable example program opens with a possible solution.

All example programs are listed under `C:\Programs (x86)\ROBOPro\Example programs\ROBO TX Automation Robots`. [Translators note: Have these directory names been programmed in English? If not, they will have to remain in German.]

**Robot, Artificial Humans?**

What is your first thought when you hear the word "robot?" Have you ever seen a robot? In a movie or on television? Or perhaps a real one?

There are many different types of robots. Some robots look a bit like a human, while others have only one or more arms. So, what exactly makes a robot a robot?

The dictionary states: "Robots are stationary or mobile machines, which perform set tasks according to a certain program."
ROBOTICS, (Almost) Everything Automatic

Thus, robots are machines controlled by a program. And we call this control of machines (or in our case models) "ROBOTICS."

The "ROBOTICS TXT Discovery Set" provides you with a wonderful start to learn about this subject. This is because the construction set contains everything you need to build and control many different machines.

You can create the programs for control of the models on a PC with the aid of the ROBO Pro 4.0 (or higher) software and then transfer them to the ROBOTICS TXT Controller using the USB or Bluetooth connection. The controller then controls or operates the model according to the program you have prepared.
Component Explanations

The construction set contains all of the following

First, it contains numerous fischertechnik building blocks, as well as motors, indicator lights and sensors and colored assembly instructions for building various models.

After you have unpacked all the building blocks, it is necessary to first assemble a few components such as cables and plugs before you can really get started. Details are given in the assembly instructions under "Assembly Tips." It is best to do this first.

Actuators

Actuators are all components, which can perform some type of action. This means that they become "active" in some way when they are connected to electric power. In most cases you can see this directly. A motor runs, an indicator light illuminates and so forth.

Encoder Motors

We use the two encoder motors, contained in the construction set, to drive our robots. At first glance, these are normal electric motors, designed for a voltage of 9 volts and maximum current input of 0.5 amperes.

But the encoder motors can do more: In addition to the connection for the power supply for the motor, they have another connector for a three-pin connection cable, which is used in combination with a so-called encoder to measure the rotation of the motor.

This encoder works the same way as a speedometer on a bicycle. A magnet (in most cases for a bicycle located on one of the spokes) passes by a sensor (attached to the fork of the bicycle in most cases) with each revolution causing the sensor to generate a pulse. These pulses can be counted, and, in the case of a speedometer, for example, multiplied by the circumference of the tire. This gives us the distance traveled.

The encoders on the fischertechnik encoder motors generate three pulses each time the motor shaft revolves once. And because the encoder motors also have a gearbox with a transmission ratio of 21:1
(read "21 to 1"), one revolution of the shaft coming out of the gearbox, corresponds to $21 \times 3 = 63$ encoder pulses.

**XS Motor**

The XS motor is an electric motor, exactly as long and high as a fischertechnik building block. In addition, it is very light. This means, you can install it at points too small for the big motors.

Both gearboxes included in the construction set fit perfectly on the XS motor.

The XS motor is designed for a supply voltage of 9 volts and a maximum current of 0.3 amperes.

**LEDs**

Two LEDs are contained in the construction set. They can be used in a variety of ways. For example as signal lights in a traffic light, as flashing lights on a robot or for better illumination of an image supplied by the camera also provided in the construction set.

The LEDs are designed for a voltage of 9 volts and consume approximately 0.01 amperes of current.

**Caution!**

When connecting LEDs to the power supply, always pay particular attention to correct polarity. Connect the positive pole to the red marking on the LED.

**Lens Tip Lamp**

This incandescent bulb contains a lens to focus the light. It looks very similar to an LED. Be careful not to mix them up. On the lens tip lamp the polarity makes no difference - this is why the socket is not marked. You need the lens tip lamp to build a light barrier in combination with the phototransistor.

The lens tip lamp is designed for a voltage of 9 volts and current of approx. 0.15 amperes.
Sensors
Sensors are so to speak the counterpart to the actuators. This is because they do not perform any actions, but react to certain situations and events. For example, a pushbutton reacts when pressed, allowing an electric current to flow or interrupting its flow. A heat sensor reacts to the temperature in its surroundings.

Phototransistor
Phototransistors are also called "light sensors". This is a "feeler" that reacts to brightness.

For a light barrier this is the counterpart to the lens tip lamp. When there is a high degree of brightness, that is when the transistor receives light from the lens tip lamp, it conducts electricity. If the beam of light is interrupted, it does not conduct any electricity.

Caution!
When connecting the phototransistor to the power supply, pay particular attention to correct polarity. Connect the positive pole to the red marking on the phototransistor.

Pushbutton
The pushbutton could also be called a touch sensor. Pressing the red button actuates a switch mechanically allowing electricity to flow from contact 1 (middle contact) to contact 3. At the same time the circuit between contacts 1 and 2 is interrupted. So you can use the pushbutton in two different ways:

As a "normally open switch" (NO or push-to-make switch)
Contacts 1 and 3 are connected.

Pushbutton switch pressed: Electricity flows.
When the pushbutton is not pressed: Electricity does not flow

As a "normally closed switch" (NC or push-to-break switch)
Contacts 1 and 2 are connected.

Pushbutton switch pressed: No electricity flows.
When the pushbutton is not pressed: Electricity flows.
Heat Sensor (NTC)

This component is a heat sensor for measuring temperatures. At 20 °C its electrical resistance is 1.5 kΩ (kilo ohms, but pronounced 'kil-ohms'). NTC stands for Negative Temperature Coefficient. This simply means that the resistance value decreases when the temperature increases.

The information provided by the sensors, for example, bright/dark, pressed/not pressed and temperature value, can, as we will see later, be transmitted by the ROBOTICS TXT Controller to a PC where it can be used in combination with the software to program a motor to drive a fan when a light barrier is interrupted.

Camera Module

The camera module is a particularly versatile type of sensor. The image resolution is 1 megapixel (meaning that each image consists of one million image dots). Connect the camera to the large USB port (USB1) on your ROBOTICS TXT Controller. The images from the camera can be transferred to the PC and viewed on the monitor. This allows you to see what your robot is doing at any particular time. Moreover the ROBOTICS TXT Controller can process the images thereby recognizing motion, colors and tracks, allowing you to control your robot model accordingly. It is also possible to connect the camera directly to a USB interface on your PC and process the images with the ROBO Pro software. This possibility is also used by a few models.

You can focus the camera image by turning the camera lens.

ROBO Pro 4.x Software

ROBO Pro is a graphic programming interface for creating programs for the ROBOTICS TXT Controller.

A "graphic programming interface" allows you to compile programs visually with the aid of graphic symbols instead of "writing" them out by
hand line for line. An example of such a program is shown at the left.

The procedure for creating such a program is described in detail in the Chapter "First Steps". The ROBO Pro Help feature also shows how this works in Chapters 3 and 4.

This software has already been installed on your PC together with this activity booklet.

ROBOTICS TXT Controller

The ROBOTICS TXT Controller is the heart of this ROBOTICS construction set. It controls actuators, and evaluates the information from the sensors.

For this purpose the ROBOTICS TXT Controller has numerous terminals for connection to the components. The instruction manual for the ROBOTICS TXT Controller describes which components can be connected to which connections and the functions of the connections.

The color touch screen allows convenient operation of your ROBOTICS TXT Controller. The camera contained in the construction set can be connected to the USB host port (USB-1). The integrated Bluetooth and WLAN interface is a particularly interesting special feature. It allows you to complete a wireless link between your PC and the ROBOTICS TXT Controller.

You can define how the controller interacts with the individual components and what they are to do in detail in the program you write with the ROBO Pro software.

Power Supply (not included)

As you know, many of the components in the ROBOTICS TXT Discovery Set need electricity to operate, so naturally you also need a power supply.

The fischertechnik Accu Set is best suited for this. It is not included in the construction set.
A Few Tips

Experimenting makes the most fun when the experiments also work. This is why you should follow a few basic rules when building the models.

Work carefully
Take your time and look precisely at the assembly instructions for the model. If you have to look for an error later, this will take much longer.

Check the movement of all parts
When putting models together continually check to see if parts, which have to move, move easily.

Use Interface Test
Before starting to write a program for a model, you should test all parts connected to the ROBOTICS TXT Controller, using the interface test feature in ROBO Pro. How this works is described in the ROBO Pro help in Chapter 2.4.
Now that you have made all of the preparations and read the information, you can finally start working.

This chapter describes how to:

- build the first simple model, a ventilating fan, and connect it to the ROBOTICS TXT Controller,
- connect the ROBOTICS TXT Controller to the power supply and PC,
- load the ROBO Pro Software and test the model,
- load and start a ROBO Pro program, and
- create and start your first simple program with ROBO Pro

Click here, to see the first, easy-to-understand steps.

Since you will be working particularly with the ROBO Pro Software in addition to the fischertechnik components themselves, you should be familiar with the details for writing programs. And because this is explained very clearly in Chapters 3 and 4 of the ROBO Pro Help, it is best at this point to continue by working through these chapters carefully.

The following tip also applies here: Take your time and concentrate; then you will have that much more fun with the models later.
Starter Models

After reading through Chapters 3 and 4 in the ROBO Pro Help, you will be able to program some of the models in the construction set. Let's get started. ROBO Pro has various levels, which you can select on the menu bar. We will start with very simple programs at Level 1. Whenever you have finished building and wiring a model, check whether all inputs and outputs on the ROBOTICS TXT Controller are properly connected and if the sensors, motors and lights all function properly with the aid of the interface test.

Pedestrian light

A pedestrian light has been installed in front of your house. Since the technician from the traffic light company doesn't have much time, you offer to program the traffic light control for him.

The man explains to you how the control is supposed to work. But first, build the model.

Task: (Level 1)

The traffic light should be red initially. When pushbutton I1 is pressed by a pedestrian the traffic light should change to yellow three seconds later and after an additional four seconds to red. The green phase is to last for 10 seconds, before the light turns red again.

Programming Tips:

The various LEDs are associated with the following outputs on the TXT Controller.

- Red – M1
- Green – M2

Turn the indicator lights on and off one after another to obtain the desired sequence.

You can load the finished program by clicking on the picture on the right.