Course description

Autonomous Mobile Robotics with Robotino 4

Difficulty	Beginner
Learning time	26 h
Additionally recommended learning media	Introduction to Robotics (eTheory), Fundamentals of Robotics (Evaluation).
Course type	eLab
Theme category	Factory Automation

After completing the training, the learners will be able to put Robotino into operation independently. They know the different sensors that are necessary for autonomous control. They can program different scenarios, such as path tracking. With the help of different technologies learners can classify and implement topics such as image processing and 3D measurement.

No.	Task	Method	Competency level	Content	Competencies	Learning time	HW/ SW dependent
1	Incoming goods inspection and commissioning of the Robotino	Guidance text supported Method	Apply	▪ Structure ▪ Function ▪ Components ▪ Function test ▪ Incoming goods inspection ▪ Driving behavior ▪ Forward / circle / square travel ▪ Commissioning protocol	▪ Able to perform an incoming goods inspection. ▪ Know the structure and function of the mobile robot. ▪ Know the individual components and functions of the mobile robot. ▪ Can perform a functional test. ▪ Know the driving behavior of the mobile robot. ▪ Can examine and perform the different options for driving behavior. ▪ Can complete a protocol independently. ▪ Know the difference between a goods receipt inspection report and a commissioning report	90 min.	Yes
2	A mobile robot system can be moved linearly in any direction.	Guidance text supported Method	Apply	▪ Omnidirectional drive systems ▪ Robot program ▪ Function block ▪ Forward / reverse travel ▪ Sequences ▪ Linear direction of travel ▪ Hash ride	▪ Know the structure and operation of the omnidirectional drive systems of a mobile robot. ▪ Know the structure of a robot program. ▪ Know the term function block and its purpose in the context of a robot program. ▪ Can control the robot in forward and reverse gear. ▪ Can create a program that the mobile robot stops when unexpected obstacles are encountered. ▪ Can create different program scenarios for the robot (waiting times, etc.). ▪ Can move the mobile robot linearly in all directions. ▪ Can create a program to make the mobile robot travel a predefined route.	180 min.	Yes

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3	Move and position a mobile robot system linearly	Guidance text supported Method	Apply	▪ Trigonometry ▪ Vector calculus ▪ Multi-axis system ▪ Motor control ▪ Measured value investigation ▪ Position accuracy ▪ Incremental evaluation ▪ Function block drive system ▪ Function block Drive System	▪ Can apply trigonometry and vector calculus. ▪ Can use a multi-axis system via motor control for a predefined trip. ▪ Can analyze a measured value investigation into the positioning accuracy of an incremental evaluation. ▪ Can perform a measured value investigation on the positioning accuracy of an incremental evaluation. ▪ Can analyze a positioning accuracy of multi-axis systems as a function of speed and travel time. ▪ Can evaluate a positioning accuracy of multi-axis systems as a function of speed and travel time.	150 min.	Yes
4	Path tracking of an automated guided vehicle system with two diffuse reflection light scanners	Guidance text supported Method	Apply	▪ Diffuse reflection light scanner ▪ I/O interface ▪ Adjustment ▪ Web Tracking ▪ Sequence program ▪ Web control ▪ Control program ▪ Collision prevention ▪ Function test	▪ Can structure complex tasks. ▪ Know the function and structure of a diffuse reflection light scanner. ▪ Can connect the diffuse sensors to the I/O interface of a mobile robot. ▪ Can perform the adjustment on a diffuse sensor. ▪ Can use a diffuse sensor to control a mobile robot. ▪ Know the concept of web tracking. ▪ Can derive strategies for web tracking. ▪ Know the structure of a sequence program and the relevant terminology. ▪ Can create a structure for a simple path control flowchart. ▪ Can replace the sequence control with a closed-loop control. ▪ Can prevent a collision with the help of the robot program. ▪ Can perform a functional test.	150 min.	Yes

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5	Accurate distance approach to a loading station	Guidance text supported Method	Rate	▪ Distance sensor ▪ Characteristic ▪ Loading station ▪ Project planning ▪ Positioning ▪ Test protocol ▪ Optimization ▪ Deceleration process	▪ Know the structure and function of a distance sensor. ▪ Can reproduce the technical data such as the characteristic curve of a distance sensor. ▪ Can program a mobile robot to approach a loading station. ▪ Know the procedure of a project planning. ▪ Can plan, perform, evaluate and document an accuracy test for positioning a mobile robot. ▪ Can create a test protocol for a program. ▪ Can reflect on the results obtained. ▪ Can implement measures to optimize positioning. ▪ Can implement a deceleration process in the control program.	90 min.	Yes
6	Approach obstacle and keep defined distance	Guidance text supported Method	Rate	▪ Sensor guided web control ▪ Odometry ▪ Navigation ▪ Positioning ▪ Parameter	▪ Can create sensor guided path control. ▪ Know the characteristics of the odometry tool for navigation of mobile robotic systems. ▪ Can use odometry to position mobile robotic systems. ▪ Know the parameters to position a mobile robot.	90 min.	Yes
7	Orbit an object and move to different transfer positions	Guidance text supported Method	Develop	▪ Distance sensor ▪ Cartesian motion ▪ Circular railroad ▪ Complex movement ▪ Parallel control ▪ Drive System function block	▪ Know the term Cartesian motion and be able to classify it. ▪ Can derive a circular path by superimposing Cartesian motions. ▪ Can use a distance sensor for closed-loop contouring control. ▪ Can develop parallel control for trajectory control for a complex motion.	45 min	Yes

No.	Task	Method	Competency level	Content	Competencies	Learning time	HW/ SW dependent
8	Path tracking of an automated guided vehicle system with an analog inductive sensor	Guidance text supported Method	Develop	▪ Analog inductive sensor ▪ Signal behavior ▪ Web Tracking ▪ Proportional controller ▪ Mounting	▪ Know the structure and function of an analog inductive sensor. ▪ Can perform a functional test with a mobile robot and the sensors. ▪ Can identify the framework for following a guideline. ▪ Can develop a control strategy to enable web tracking with an inductive sensor. ▪ Can perform control behavior by modifying a proportional controller.	120 min.	Yes
9	Robotino motor control	Technical exploration	Apply	▪ Amplitude ▪ Frequency ▪ Square / sine / triangle signal ▪ Oscilloscope ▪ Control engineering ▪ Step response ▪ Dynamics ▪ Interpretation ▪ Motor control	▪ Know the terms amplitude, period and frequency. ▪ Can classify the terms and reproduce their meaning. ▪ Know the different signal waveforms such as square wave/sine wave/triangle waveform. ▪ Can record and display the signals using the oscilloscope. ▪ Can analyze the dynamics of a controlled system. ▪ Know the term step response and can reproduce it. ▪ Can evaluate the controller definition of a motor controller.	90 min.	Yes
10	Path tracking of an AGV with the help of a camera	Technical exploration	Develop	▪ Camera ▪ Line detection ▪ Limitations of line detection ▪ Web Tracking ▪ Program creation ▪ Line detector function block ▪ Image processing	▪ Know the structure and function of the camera on a mobile robot. ▪ Can access the camera of a mobile robot. ▪ Can perform a commissioning of the camera on a mobile robot. ▪ Know the limits and constraints of line detection ▪ Can derive trajectory tracking strategies using a camera. ▪ Can create a robot program for path tracking with a camera.	90 min.	Yes

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11	Search and approach colored objects	Technical exploration	Develop	▪ Color recognition ▪ Search procedure ▪ Field of view ▪ Program extension ▪ Image processing	▪ Know the function of color recognition on a mobile robot. ▪ Are able to configure and apply the factory recognition function on a mobile robot. ▪ Can apply a search procedure in software for colored objects. ▪ Can extend an existing program with the search procedure. ▪ Can track and control the location of colored objects while driving from a mobile robot.	90 min.	Yes
12	Use of the 3D measurement functionality of the camera	Technical exploration	Develop	▪ Camera ▪ Distance measurement ▪ Measurement instability ▪ Odometry accuracy ▪ Dynamic distance measurement ▪ Program creation ▪ Laser function block	▪ Can measure obstacles or their distance with the help of the robot camera. ▪ Can smooth the measurement instability of the camera with a function block. ▪ Can check the odometry accuracy with a camera measurement. ▪ Can measure the different viewing directions of the mobile robot and thereby align it. ▪ Can check a dynamic distance when approaching obstacles. ▪ Can create a robot program to find from an unknown position to a target position.	150 min.	Yes
13	Create an environment map for Robotino	Technical exploration	Develop	▪ Surrounding map ▪ Navigation ▪ SLAM method ▪ 3D measurement ▪ Image processing	▪ Know the concept of environment map for navigation of mobile robots. ▪ Know the concept of the SLAM method. ▪ Know the software used to create environment maps. ▪ Can independently generate a file for an environment map. ▪ Can control a mobile robot using the software. ▪ Can create and edit a working environment for a mobile robot in the form of an environment map.	60 min.	Yes

No.	Task	Method	Competency level	Content	Competencies	Learning time	HW/ SW dependent
14	Navigation in the surrounding map	Technical exploration	Develop	▪ Methodology ▪ Surrounding map ▪ Autonomous ▪ Orientation ▪ Defined position ▪ Travel routes ▪ 3D measurement ▪ Image processing	▪ Know a method to identify the real position of the mobile robot in an environment map. ▪ Can control the mobile robot manually with the help of the environment map. ▪ Can translate positions with a given orientation in the real world of work into an environment map. ▪ Can use a program to make the mobile robot drive autonomously to a position defined in the environment map. ▪ Can describe the real driving routes with the help of the surrounding map.	90 min.	Yes
15	Approach marker autonomously	Technical exploration	Develop	▪ Surrounding map ▪ Manual drive ▪ Three dimensional map ▪ Function block diagram ▪ Lua ▪ Marker recognition ▪ Start position ▪ Approach position ▪ Robot program ▪ 3D measurement ▪ Image processing	▪ Can identify the real position of a mobile robot in an environment map. ▪ Can manually control a mobile robot using a map of the environment. ▪ Can use the camera's three-dimensional mapping system. ▪ Can recognize the mobile robot with the help of the camera a graphic barcode (marker). ▪ Know the functional block diagram of mark recognition. ▪ Can apply the functional block diagram for marker recognition. ▪ Can write a custom function block in Lua to perform marker detection control. ▪ Can set a path from an arbitrary start to an approach position (marker) using the environment map. ▪ Can use software to create a program to have the mobile robot move autonomously via a stay start position to a precise maker position.	90 min.	Yes