Festo **LOGISTICS COMPETITION 2011**

ENGINEERING REFERENCE

013

This booklet includes descriptions and features of the Robotino platform and hardware incorporated into the competition area.

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1.1 The Mobile Robot System

The mobile robot system Robotino® is a platform with an open mechanical interface for the integration of additional mechanical devices and an open electrical interface to integrate easily additional sensors or motors of devices. Power is supplied via two 12 [V] lead gel batteries which permit a running time of up to two hours. The scope of delivery likewise includes a charging device.

Robotino® is driven by 3 independent, omnidirectional drive units. They are mounted at an angle of 120° to each other. The three omnidirectional drive units of Robotino® , defines the robot as being holonomic, meaning that the controllable degrees of freedom equals the total degrees of freedom of the robot. The drive units are integrated in a sturdy, laser welded steel chassis. The chassis is protected by a rubber bumper with integrated switching sensor.

Robot dimensions:

Diameter: 370 mm
Height including housing: 210 mm
Overall weight: approx. 11 kg
Maximal payload of about 6 kg

1.2 Drive Unit

Each of the 3 drive units consists of the following components:
DC Dunker motor with nominal speed of 3600 rpm and nominal torque of 3.8 Ncm. Integrated planetary gear unit with a gear ratio of 4:1. Omnidirectional wheels of diameter of 80 mm. Toothed belt with gear wheels providing a transmission ratio of 4:1.

Altogether this provides a gear transmission ratio of 16:1. Incremental encoder with a resolution of 2048 increments per motor rotation.

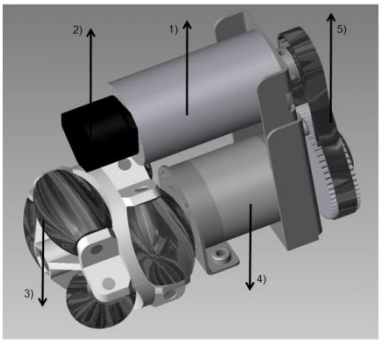

Figure 1 Drive unit with motor (1), encoder (2), omnidirectional wheel (3),

The motor speed will be controlled via a PID controller implemented on a Atmel microprocessor of the controller board of Robotino®.

1.3 Sensors

Robotino® is equipped with 9 infrared distance measuring sensors which are mounted in the chassis at an angle of 40° to one another. Robotino® can scrutinise all surrounding areas for objects with these sensors. Each of the sensors can be queried individually via the controller board. Obstacles can thus be avoided, clearances can be maintained and bearings can be taken on a selected target.
The sensors are capable of accurate or relative distance measurements to objects at distances of 4 to 30 cm. Sensor connection is especially simple including just one analogue output signal and supply power. The sensors' evaluation electronics determines distance and read it out as an analogue signal.
The anti-collision sensor is comprised of a switching strip which is secured around the entire circumference of the chassis. A reliably recognisable signal is thus transmitted to the controller

unit. Collisions with objects at any point on the housing are detected and, for example, Robotino® is brought to a standstill.
The inductive proximity sensor is supplied as an additional component. It serves to detect metallic objects on the floor and is used for continuous-path control, e.g. it might be used to detect the blue lines (metallic stripes) on hockey field. It reads out signals of varying strength depending upon whether it is located in the middle or at the edge of the metal strip. Path tracking can thus be controlled in a differentiated fashion.

The inductive proximity sensor must be attached to the mounting furnished for this purpose, and must be connected to the I/O interface. The output voltage is 0 to 10 [V]. The sensing range is 0 to 6 mm. Path tracking can also be implemented with the two included diffuse sensors. Flexible fibre optic cables are connected to a fibre-optics unit which works with visible red light. Reflected light is detected. Different surfaces and colours produce different degrees of reflection. However, gradual differences in reflected light cannot be detected. The sensors must be attached to the mountings furnished for this purpose, and must be connected to the I/O interface.

Robotino® is equipped with a colour webcam. The webcam is equipped with a USB interface. Also, there will be integrated a digital Gyroscope providing a high accuracy of the odometry in the virtual factory.

1.4 Controller Board – 2010 Revision

The controller housing is connected to the wiring in the chassis via one plug-in. Thus you can easily take off the controller housing and you have direct access to the mechanical system. The controller system of Robotino® is divided into two parts – an embedded PC and a microcontroller interface card:
The Controller of Robotino® consists of an embedded PC and a microcontroller interface board. The main controller is the embedded PC 104 plus controller with the 800 MHz processor AMD LX800. The PC has a SDRAM of 128 MB and is provided with a 1 GB flash card. There are numerous communication interfaces on board:

- 2x 100 Mbit Ethernet
- 2x external USB, 1x internal USB, 1x on-board USB-connector
- 2 x RS232
- Parallel port and VGA port
- Wireless LAN Access Point following the standards 802.11.g and 802.11.b.
- The access point can be switched into a client mode. As an option you may use WPA2-coding.

1.5 Software

Preinstalled is an Ubuntu Linux operating system with real time kernel running on the embedded PC 104. The main part of the controller is the Robotino® server, a real time Linux application. It controls the drive units and provides interfaces to communicate with external PC applications via WiFi. There is an API with libraries which allow you to create applications for Robotino® in numerous programming languages:

- C++ und C
- C#
- .net and JAVA
- MatLab and Simulink
- Labview

You may find a lot of examples concerning using the different API's in the public forum "openrobotino", http://www.openrobotino.org

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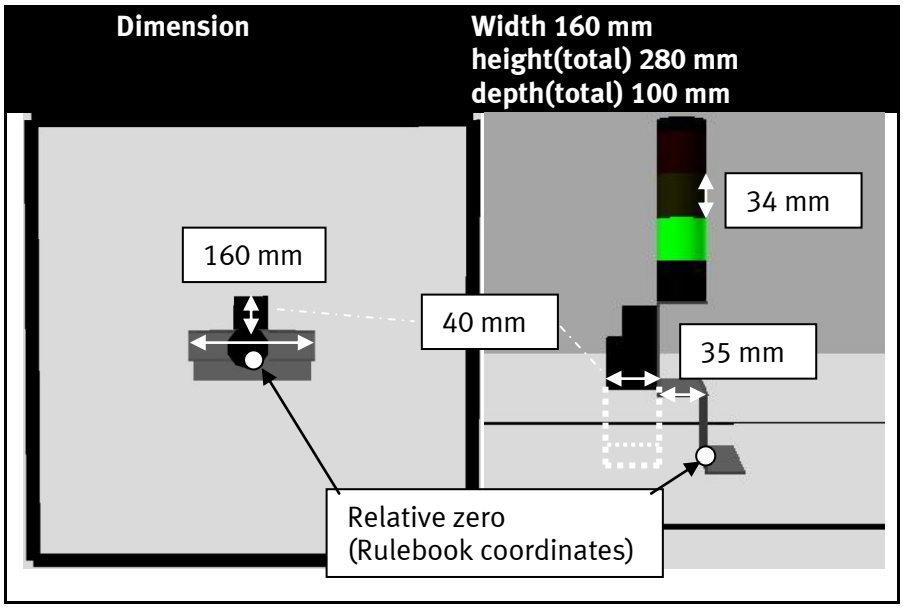
1.5.1 Robotino® View

Robotino® View is a graphical programming language with numerous prepared function blocks you can easily connect via input and output parameters to establish more complicated function diagrams. You can use these function diagrams as subprograms for more complex programming sequences. To build up general programming sequences Robotino® View follows the international standard IEC 61131-3.
You may run Robotino® View on an external PC and Robotino® View communicates directly with the Robotino® Server on the PC 104 via WiFi in order to control the robot system. The function blocks receive a direct feedback of the hardware components such that you can live interact with the robot system. On the other hand you can download Robotino® View programs into the PC 104 in order to run the applications completely autonomously. There is a well defined interface to develop own function blocks in C++ or Lua.

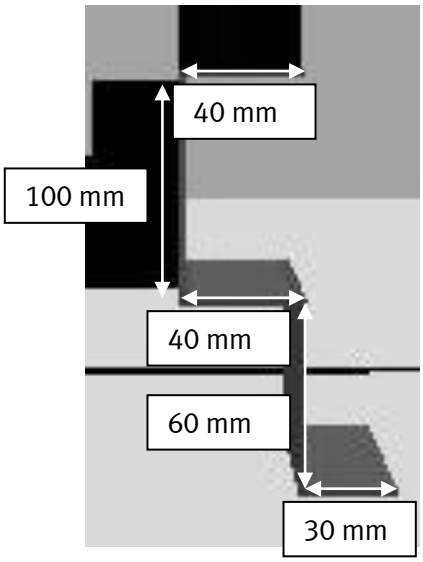
1.6 Image Processing

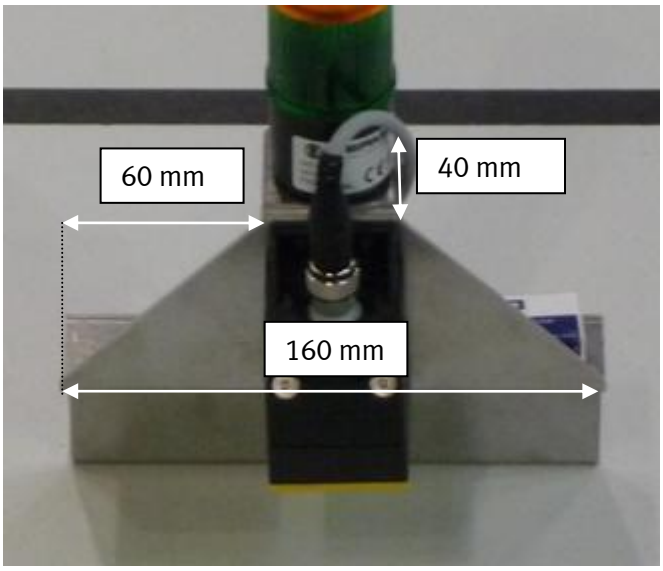
Depending on the Robotino version it might happen that the standard web camera only provides image data by jpeg compression. This is very useful if you run your image processing on the PC and exchange the data via WiFi. However, if you would like to run your image processing algorithms on the Robotino controller then the processor is not powerful enough in order to pack and to unpack the image data in a reasonable time. Thus we recommend for running image processing algorithms on the Robotino controller to use a camera without jpeg compression, e.g. use the low cost Logitech web camera C250.

2 Machines



2.1.1 Bracket





2.1.2 Signal

	Dimension	diameter 36 mm height(total) 147 mm
	Segment height	34 mm, including 5 mm unlighted border
	Lifespan	max. 50.000 h
	Connector	Bottom, 2m supplied Compatible to the I/O-Terminal of MPS(r) units.
	Safety	IP65
	Voltage	24V
	Current	3 times 40 mA
	Kind of current	DC
	Operating mode	-20°C to +50°C
	Signaltype	Static LED
	Signal	Ultrabright LED
	Source	Festo # 549843

2.1.3 RFID device

	Technical data of the read/write head: Housing rectangular:	
	Housing and working dimensions:	40*40 mm with the centred RFID tag.
	Housing height:	65 mm
	Operating voltage	DC
	Housing material Plastic:	PBT-GF30-V0, black
	Material active face Plastic:	PA6-GF30, yellow
	Operating voltage	10...30 VDC
	DC rated operational current: ≤	80 mA
	Data transfer	inductance coupling
	Working frequency:	13.56 MHz
	Radio communication and protocol standards	ISO 15693
	Read/write distance:	max. 115 mm
	Output function	4-wire, read/write
	Electrical connection	Connectors M12 x 1
	Vibration resistance	55 Hz (1 mm)
	Shock resistance	30 g (11 ms)
	Protection class	IP67
	Operating voltage display	LED green

3 WiFi equipment

Detail	Value
Festo AP	LANCOM L-322agn
Transfer rate	Up to 108 Mbps
Data link protocol	802.11 a/g/n
Frequency	5.0 Ghz
IP-distribution	172.26.200.xxx for LAN clients(DHCP) 172.26.101.xxx for the Robotino devices 172.26.1.xxx for Robotinos Subnetmask: 255.255.0.0
Encryption	Unsecured
SSID	Separated for both teams: RobotinoEvent.1 + RobotinoEvent.2
Festo Clients	3COM WL-560
Power Supply	Clients: 12 VDC, 1A, Most Laptops cannot power them via USB!
Connector	Ethernet

4 Data carrier

Dimension:	Ø 20 mm height: 2.5 mm
Data transfer:	inductance coupling
Working frequency	13.56 MHz
Memory read/write	
Memory type	EEPROM
Memory size	128 Byte
Freely usable memory	112 Byte
Number of read operations	unlimited
Number of write operations	105
Typical read time	2 ms/byte
Typical write time	3 ms/byte
Radio communication and protocol standards	ISO 15693

Item	Stored Data
S0	10000
S1	20000
S2	30000
P	40000
Consumed	00000