KeTop T10
directMove

Operate robots quickly and easily
using intuitive gestures

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Automation by innovation.

KeTop T10 directMove
New prospects

System overview

The KeTop T10 is a machine operating device that is intended for jogging robots in an intuitive way with „DirectMove“. DirectMove is the name for operating a robot or a machine on the basis of position detection in or parallel to the pointing direction.

Compared to a conventional KeTop the KeTop T10 is equipped with a firmware for calculating the orientation of the device and for communication with the control, since it has a limited graphical interface.

The key benefit of the KeTop T10 is the knowledge about it’s own orientation in space. This way the KeTop T10 can be used for selecting desired directions of movements. Similar to show a direction to a human operator using ones finger.

Although the KeTop T10 is designed for jogging robots, it can be used for any application, where it is useful to show directions or orientation in space by using the device itself.

An integrated emergency stop and an enabling control switch make it the perfect operating device for any machine requiring save manual operation.

The new, intuitive way of operation together with its compact size allows the operator to concentrate on the operated machine instead of paying attention to the operating device.

The display of the KeTop T10 is used to display the status and shows the icons setted by the application on the control. An exception are the error codes or internal icons (e.g. compass for referencing) which are displayed directly by the KeTop T10.

The following chapters offer an overview of the following topics:

- KeTop T10 functions
- Connecting the KeTop T10 to an OEM control
- Using the KeTop T10 for robot jogging

Functions of KeTop T10

In principle the KeTop T10 is a operating device with keyboard, joystick and a small color LCD display for showing operating modes and status. But in addition to that the device has knowledge about its own orientation in space. This information is used by the robot control to handle the robot.

The KeTop T10 itself has no built-in logic for robot jogging and no specific information about it. This way it is up to the controller to implement the best way of using the device in a special context.

The display is quite reduced in function: It only allows the selection of predefined icons representing mode and state information. There are several icon sets available which are stored in the KeTop T10 itself.

The KeTop T10 has an Ethernet interface which allows exchanging information with the control. The following information is exchanged between controller and the device:

- state of keyboard and joystick
- current orientation of the device
- current selected icons for display

As a communication protocol KVC (KEBA Virtual Channel) based on UDP/IP designed by KEBA is used. The protocol also implements a transfer of parameters. Parts of the data exchange are handled cyclically like a live check to detect connection errors between KeTop T10 is active.

The communication protocol is integrated into the firmware of the KeTop T10. The firmware also contains all (inertial) sensor evaluation to derive the orientation of the device. Furthermore a small web server on the device allows basic diagnosis and network settings.

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Show the robot the way

Inertial sensor processing

The KeTop T10 contains a 6D IMU (inertial measurement unit), consisting of 3 accelerometers and 3 gyroscopes, which measure the motion of the device in space.

The sensor software contains all necessary sensor processing and state control to provide the robot control with the current orientation of the device and filter undesired vibrations like e.g. from tremor of the hand of the operator.

To get reliable orientation results from the sensors, the sensors have to be calibrated at the beginning of operation. This is done automatically after powerup as soon as the device is in rest position. Due to the inertial sensors the KeTop T10 only can calculate the orientation relative to the starting orientation.

Therefore before operation the KeTop T10 has to be put in a defined orientation relative to the robot. The automatically calculated orientation is stored as reference direction via the reference button.

Sensor errors lead to a growing deviation of the orientation in horizontal direction. To keep the quality of the orientation at a high level the KeTop T10 has to be referenced about every 10 minutes.

The user can check the accuracy of the current orientation at any time by activating device‘s own orientation button.

The used gyro sensors (measuring angular speed), have a measurement range of 2000°/s. If this range is exceeded it is necessary to restore the original orientation by re-referencing.

Integration of the KeTop T10 into robot control

The KeTop T10 is equipped with an Ethernet interface for exchanging I/O data between device and control. The hardware interface is compatible with the standard devices of the KeTop product line. So KeTop T10 may be used alternating with another KeTop device on one control without hardware change.

Software structure

KVC is used as a communication protocol for exchanging data between device and control and provides means of:

- I/O data exchange (keyboard, joystick, orientation and display information)
- Connection live check
- Parameterization of KeTop T10

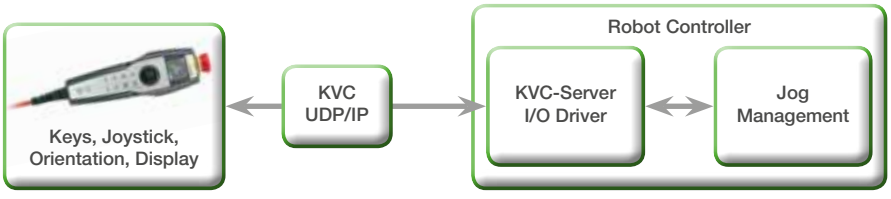
For connecting KeTop T10 to a robot control additionally to the required I/O device driver using KVC protocol the integration to the jog management has to be implemented (the management evaluates the user interactions with the controls of the KeTop T10 and derives mode, direction and speed for robot jogging).

KVC Server Development Kit

The KVC SDK (Server Development Kit) supports a quick implementation of the driver software for the control. The KVC SDK contains a reference server implementation in the programming language “C” for Windows delivered as source and a KeTop T10 emulation that can be used for testing a KVC driver implementation.

The reference implementation is containing all operating system dependent functions in a module to make porting to different operating systems an easy task. Furthermore the reference server is integrated in a test program. This dialog based application provides all functions of the KVC communication for interactive test.

KeTop T10 integration, Software structure *



*** Further information:**
A technical product handbook as well as a handbook for KVC (including Demo and SDK) are available at KEBA.

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Flexibility with 4 operating modes

Using KeTop T10 for jogging a robot

Robot jogging usually is performed using predefined coordinate systems as world coordinates or tool coordinates. Usually the robot is moved in a desired direction by pressing a button or deflecting a joystick.

Using KeTop T10 for jogging a robot is quite similar. But instead of selecting a desired axis with a special button, the axis is shown in space with the device itself (e.g. for selecting the vertical axis the KeTop T10 is held in vertical direction, for jogging horizontal the KeTop T10 is held horizontal, and so on). For adjusting jog speed and positive or negative direction the joystick is used. So the direction and movement of the thumb always directly corresponds to the robot movement, which is the most intuitive way. The joystick can also be moved toward the operator to make intuitively a movement of the robot towards the operator.

The buttons on the KeTop T10 can be used for selecting different jog modes and coordinate systems. The display can be used for showing selected modes and additional information, such as error status. The following chapter gives a suggestion, how to use a KeTop T10 for jogging a robot.

Suggestion for jog functions

As the robot control is in charge of the jog functions, any modifications are possible. The suggested function set is a typical implementation which has proved useful in field tests by KEBA.

The KeTop T10 provides a joystick with a button function which is used for jogging or moving the robot. The jog operation can be switched between Cartesian coordinates and robot joints. Furthermore the KeTop T10 provides a new motion mode for the alignment of the Tool Center Point (TCP) without changing the position, called „virtual handle mode“.

Jogging in Cartesian space

One of the following Cartesian modes can be chosen:

- Free mode (free movement)
- Coordinate mode - movement of the robot is aligned to coordinates (“snap-to-grid”)

In free mode the direction of the KeTop T10 directly gives the direction of movement without aligning to a coordinate system.

In coordinate mode the directions are defined by a selected coordinate system (world / object / tool). Also several tool coordinate systems can be defined and selected. The axis of movement is selected by the direction of the KeTop T10 itself and corresponds to the axis of the coordinate system which is closest to the axis defined by the length dimension of the KeTop T10. Coordinate mode can be seen as a kind of "snap-to-grid" variant of the free motion mode.

Advantage of the free mode is that any arbitrary direction of robot motion can be achieved. Coordinate mode is useful for jogging very precisely when fine adjusting robot position.

The joystick is used to control the jog speed in either translation or rotation. Deflecting the joystick forward and backward activates translation along the selected (= pointed with the device) axis. Deflecting left and right activates rotation around the selected axis.

This way position and rotation of the robot can be changed in alternation very easy without any operation mode switching. Thus the movement of the thumb directly corresponds to the produced movement of the robot. A simultaneous translation and rotation is locked by the firmware. Therefore an diagonal deflection of the joystick results in the activation of the movement (translation/rotation) which is interpreted by the device.

The direction of the KeTop T10 can be changed during active jogging at any time. This results in a continuously changing motion direction in free mode and a direction jumping from one axis of the coordinate system to the next in aligned mode (= integrated tracking functionality).

Jogging robot joints

The keypad is used for toggling jog mode between Cartesian mode and joint mode. In joint mode the joystick is used for jogging the active joint. The active joint can be selected by the keypad (keys „Plus" and „Minus").

Virtual handle mode ("grabbing")

When the joystick is pressed, the Tool Center Point (TCP) follows directly any orientation change of the KeTop T10. This gives the impression of grabbing the TCP directly and changing the orientation manually. So the KeTop T10 serves as a virtual handle of the TCP. The position of the Tool Center Point itself is unchanged. Due to safety standards the rotation speed of the robot is limited in virtual handle mode. When the KeTop T10 is rotated nearly in the allowed speed limit in grab operation, a warning is displayed, and if the speed is too high, the robot movement will be stopped.

All motion functions (translation, rotation, grab) are locked against each another to prevent unexpected behavior of the robot.

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KEBA AG was founded in 1968 and is an internationally successful electronics company headquartered in Linz (Austria) with branch offices worldwide. In line with its credo, “Automation by innovation” KEBA has been developing and producing inventive, top quality automation solutions for 45 years for industrial, banking, services and energy automation branches.

Indeed, as a result of competence, experience and courage, KEBA is the technology and innovation leader in its market segments. Extensive development and production expertise have proved a recipe for highest quality.

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