Getting Started

This guide provides the information required to successfully install and run demonstration programs on your Mekabot. The software for your Mekabot is based on M3 and ROS. For more additional operation and programming instructions, visit the M3 Wiki [http://www.mekabot.com/wiki].

Safety

Indemnification*: Customer shall bear responsibility for any loss, claim, damage, liability or expense against it, including court costs and reasonable attorney's fees due to bodily injury, including death, or property damage sustained by customer, its employee, contractors, agents, invitees and licensees which arises out of, is occasioned by or is in any way attributable to the use or misuse of this hardware.*

The Mekabot is a potentially dangerous tool and should be treated accordingly. Although it has inherent safety mechanisms in its hardware and software, there is always the potential for harm, even when used according to proper operating procedures. We advocate the following safe practices:

1. Keep the E-Stop close. Always keep the E-Stop close at hand when operating the robot. When running code for the first time, it is advised to keep one hand on the E-Stop and carefully watch for unexpected joint accelerations.
2. Limit start-up torques. Ensure that your program does not generate large torques at start-up. This can often occur when a controller is attempting to zero out a control error that is significant before the motors are powered on.
3. Supervise children and visitors. There are several possible pinch-points in the robot arms. Children have small hands and fingers that can be crushed in a pinch point during normal robot operation.
4. Keep away from food and drink. The robot is not sealed and any liquids accidentally spilled on the robot can cause serious damage to the robot electronics.
5. Verify operation in simulation. When testing new code it is advised to first verify the operation using the ROS RViz visualization program. Verify that all joint trajectories are smooth and that self-collisions do not occur.
6. Do not leave unattended. Always depress the E-Stop to de-power the motors when leaving the room or when pausing your work.

Electrical

The robot can be operated from either the 24V power supply, or with a 24V battery pack. When using the power supply, it is recommended using a wall outlet with a well grounded plug. Be sure to verify this before using the power supply.

A power supply must be provided by the customer for this system. **Before powering the robot for the first time, plug the supply into the wall and verify the output voltage using a digital multimeter.** Verify that the supply voltage is 24V+/-3V.

Nominal current draw when the motors are not powered is 0.5A@24V. When the motors are powered, the current draw varies according to the load. During high dynamic motion, momentary peak-currents can reach 5A.

Computaton

Each Meka robot ships with a pre-configured Real Time PC (RTPC). The particular make and model of the machine will vary. The desktop-RTPC is provided for stationary systems and mobile-RTPC is provided for mobile systems. The key pre-installed software on the RTPC is:

1. Ubuntu Linux compiled with RTAI
2. EtherLab EtherCAT Master
3. Meka M3 software
4. Willow Garage ROS software

The RTPC requires an EtherCAT compatible Ethernet NIC. For a desktop-RTPC a compatible PCI-E NIC is already installed and configured. For a mobile-RTPC, the motherboard has a compatible NIC installed.

We also recommend a strong familiarity with Linux command-line tools and installation procedures.

Networking

Setting up:

- One Ethernet NIC on-board the RTPC is configured for used with EtherCAT. This network interface should not be modified.

Power Board

Only controls motors, not cameras. Firewire=motor control

The Meka PowerBoard back panel has the following items:

1. **PWR Plug**: 24VDC input capable of 3A continuous
2. **Motor Power LED**: Off = Flashing ; On = Solid
3. **EtherCAT**: CAT5/6 cable from RTPC
4. **Remote**: CAT5/6 cable from E-STOP
5. **Digital Power Switch**: Powers all embedded controllers
6. **Digital Power LED**: Lit when Digital Power is enabled
7. **AUX Ports**: For optional Firewire or USB sensors

Cables

The following cable installation is required:

1. CAT5/6 cable from Back-Panel E-STOP port to the E-STOP
2. CAT5/6 cable from Back-Panel ETHERCAT port to the RTPC Ethernet NIC installed on the PCI-E bus

Important!

3. Power cable from the Back-Panel PWR port to the 24V Power-Supply

Double check that the E-Stop cable is not plugged into the EtherCAT port. The power cable utilizes the Amp

PowerLoc 54483-3 connector.

Start Up

Power On

To power on the robot:

1. Ensure that all cables are properly installed
2. Ensure that the E-STOP is depressed
3. Turn on the Digital Power Switch and verify the Digital Power LED comes on

4. Start with kernel 2.6.32.20-rtai-3.9 (otherwise nothing will work)

EtherCAT Bus

To check the EtherCAT slaves on the bus, execute the 'lsec' command from the RTPC. It will list the current slaves on the bus and their state (INIT/INIT_E/PREOP/OP). The head will appear similar to:

```
meka@meka-mars:~$ lsec
0  0:0  PREOP  +  M3 ECHUB EtherCat Hub [Name: EH013 ; SN: 1008]
1  0:1  PREOP  +  M3EC ActX3 Controller [Name: MH14J2J3J4 ; SN: 716]
2  0:2  PREOP  +  M3EC ActX2 Controller [Name: MH14J0J1 ; SN: 715]
3  0:3  PREOP  +  M3EC PWR Controller [Name: PWR013 ; SN: 623]
```

Occasionally the EtherCAT master may have difficulty initializing the bus. If the slaves do not show up as expected, power-cycle the Digital Power Switch and try again.

Controllers

The head support the following control interfaces:

- CURRENT: For debug testing only.
- THETA: Direct position control with no underlying torque loop.

Software Interface

To control the S3 head a ROS topic is available to send commands to from a client script. ROS is Willow Garage's Robot Operating System for non-RT tasks with support for trajectory planning, manipulation, and collision detection

Starting S3 ROS node

First start the M3 server:

```
m3rt_server_run -m
```
(just a server, let it running in a separate terminal)

Ensure that the M3Humanoid Shared Memory component is available:

```
m3humanoid_shm13
```
m3humanoid_shm_test

outdated

Start roscore:

```
roscore
```
(just a server, let it running in a separate terminal)

Now start the M3Humanoid ROS interface:

```
rosrun shm_humanoid_controller shm_humanoid_controller
```
(let it running)

Check that the ROS topics are available

```
rostopic list
/humanoid_command
/humanoid_state
```

This example [https://mekabot-dev.com/svn/m3meka/trunk/ros/shm_humanoid_controller/src/move_humanoid.cpp] moves the J0 joint of a right arm. It serves as a template for general ROS based control of the M3Humanoid joint position. To move J0 of the head instead of the arm, modify the example as follows:

$ rosrun shm_humanoid_controller move_humanoid

```
humanoid_cmd.chain[0] = (unsigned char)HEAD;
humanoid_cmd.chain_idx[0] = 0; //J0
humanoid_cmd.control_mode[0] = (unsigned char)JOINT_MODE_ROS_THETA; //Compliant position mode
humanoid_cmd.smoothing_mode[0] = (unsigned char)SMOOTHING_MODE_SLEW; //Smooth trajectory
humanoid_cmd.velocity[0] = 3.0; //Rad/s
humanoid_cmd.stiffness[0] = 1.0; //0-1.0
humanoid_cmd.position[0] = 0; //Desired position (Rad)
```

Testing Head Flea3 Camera

On auxiliary PC, run coriander or flycap software to see camera output.

Using ROS:

rosrun camera1394 camera1394_node _guid:=00b09d0100be2463 _veo_mode:=1600x1200_yuv422 _iso_speed:=800 _frame_rate:=15

rosrun image_view image_view image:=/camera/image_raw

Testing PrimeSense 3d Sensor

Note: Updating ROS on meka-marble may break driver for PrimeSense and require additional updates. Please make disk image of backpack PC meka-marble before updating ROS in case you need to rollback.

Note: The 3d sensor is plugged into the backpack PC meka-marble through the head USB hub.

To use sensor, see: http://www.ros.org/wiki/openni_launch [http://www.ros.org/wiki/openni_launch] we do not have this (or any) stereo camera!

Testing Bumblebee X3 Firewire Cameras

On backpack PC meka-marble, run coriander software to see camera output.

Note: DMA buffer should be set to size 2 to prevent visual distortion

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