

# H2 Compliant Hand



#### Overview

The Meka H2 Compliant Hand is a fully-contained five degree-of-freedom humanoid hand. It has a is approximately human size with intrinsic physical compliance and haptic feedback, making it ideal for researchers interested in dexterous manipulation within human environments.

The H2 hand has a unique under-actuated design that provides remarkable dexterity. It has a total of 12 DOF controlled by 5 actuators. This also allows each finger to automatically adapt its shape to an object, thereby increasing the grasp contact area and stability. In addition, the fingers are very robust to impact and deformation due to their multi-durometer cast urethane construction.

Each finger is driven by a Series Elastic Actuator. By placing a spring between the motor and the finger drive tendon, the H2 hand

Total DOF	12
Actuated DOF	5
Interface	M3 EtherCAT
Motor Power	24V@3A peak
Digital Power	9-15V@300mA
Weight	800g
Grasp Payload	2.0 Kg
Angular resolution	.022 degree
Open-Close speed	0.8 s

Preliminary specifications. Subject to change.

achieves high-fidelity control of the tendon force. This physical compliance also improves robustness to impacts and the ability to maintain stable force-closure during grasping.

The H2 hand is plug-and-play compatible with the Meka M3 control software and A2 manipulators.



# **Electrical Properties**

The H2 hand requires 24VDC@ 3A peak for motor power. This is exposed through a Hirose DF3 connector (DF3-2S-2C). The digital EtherCAT bus requires 9-15V@300mA over a standard FireWire cable. All required electrical connections are brought out from the Meka A2 arm mount plate. When used without the A2 arm, the M3 EtherCAT hub is required.

# **Mechanical Properties**

The hand weighs 800g and can maintain a stable grasp on 2.0Kg objects. The open-toclose grasp speed is 1.2s. The hand attaches through 4xM3 bolts to a user provided mounting plate, ATI force-torque sensor, or Meka A2 series arm. The overall size is 190x96x63mm as shown below.



# **Kinematics**

The 12 under-actuated DOF of the hand have the kinematic structure shown above. A single actuated tendon controls the grip strength of each finger.

# Sensing

Each actuator has force feedback through a 12bit Hall Effect sensor measuring the Series Elastic Actuator spring displacement. Each actuator also measures the tendon position using a 12bit absolute encoder. This corresponds to the overall finger curvature. Because the finger is under-actuated, the true finger pose is not uniquely determined using this sensor alone.

Each actuator also provides sensing of the motor current, the motor temperature, and the amplifier temperature. These values are monitored in the hand firmware for overcurrent and over-temperature safety conditions.



#### 1240 PENNSYLVANIA AVE, SAN FRANCISCO, CA 94107. PH: 415.206.0131

### **Control and Software**

The hand is shipped with the following controllers ready to run:

- Force closure for power grasping
- Joint angle for gesturing
- Joint angle with variable stiffness for exploration of unknown objects

The hand has embedded DSP controllers which relay data on the EtherCAT bus at 1Khz. The included M3 EtherCAT hub interfaces to a PC or laptop using a standard CAT5 Ethernet cable. The real-time control PC (RTPC) runs Ubuntu Linux, RTAI, and the M3 control system. One RTPC is included with each robot system.

The M3 control system provides:

- A plug-in based real-time C++ control architecture allowing for easy design of custom controllers.
- A calibrated (SI) view on all sensors and actuators
- Integrated Orocos KDL kinematics and dynamics functionality
- Smooth Spline and Minimum Jerk joint trajectory control
- Inverse kinematics and dynamics control
- A XML-RPC and TCP/IP server for scripting by external Python clients
- An Python API for controlling the H2 hand posture and forces.
- Support for the Willow Garage Robotics Operating System (ROS) and its ODE based physical simulator.
- Open-source GPL licensing.

The M3 API can be found here: <u>https://mekabot-dev.com/m3doc/html/index.html</u>

#### Options

- Integrated Pt Grey Firefly MV camera for eye-in-hand vision systems.
- Integrated ATI Mini40 SI-80-4 six axis force-torque sensor.
- Lab bench mounting chassis
- Enclosed bulk power-supply

#### Sales

Contact info@mekabot.com for current pricing. Purchase includes:

- Meka H2 Hand
- Meka M3 Power Board
- Meka M3 EtherCAT hub
- Meka M3 control software and H2 hand calibration files.
- Preconfigured Dell Core Duo RTPC
- One year, no-cost unlimited support including parts, travel, phone and email.