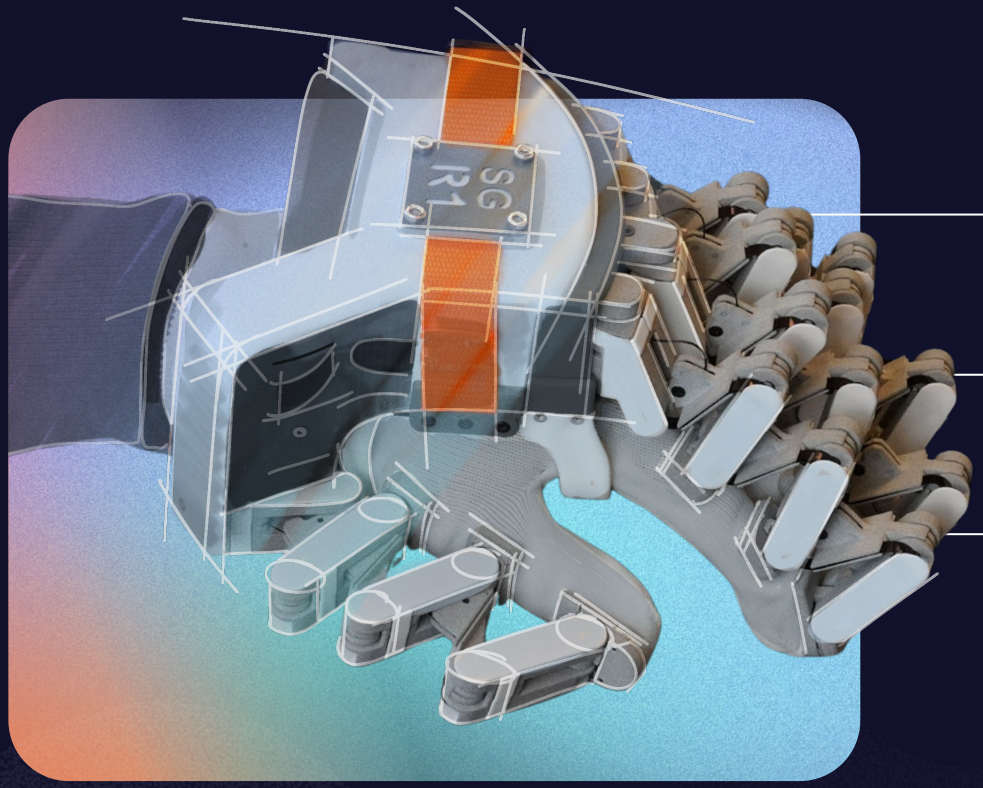
Haptic Glove for Tele-robotics & Imitation Learning

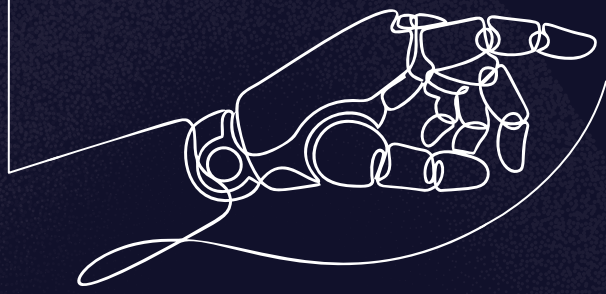
SENSEGLOVE **R1**



LATENCY
10 ms R1 to PC

UPDATE RATE
up to 1 kHz

SOFTWARE
Python (3.8+) API
ROS 2



APPLICATIONS

Tele-operation of robotic hands
Imitation learning using haptic feedback
Dexterous manipulation in robotics research
Integration into XR-supported robotic systems
Training the workforce of the future

HAPTIC FEEDBACK

ACTIVE FORCE FEEDBACK
on thumb and 3 fingers
resistive force up to 25 N
active force up to 3,5 N

VIBROTACTILE FEEDBACK
on all fingertips hand palm
vibration force >2.0 Gp
at resonance frequency

SENSING

FINGER TRACKING
40-DoF exoskeleton sensing for real-time control of 20-DoF humanoid robot hands

GRIP FORCE
sensing up to 20 N per finger with 0.01 N resolution

HAND ORIENTATION
9-axis absolute orientation sensor

SENSEGLOVE

OVERVIEW

R1 is a high-precision haptic glove developed for the tele-operation of dexterous humanoid robotic hands. With 40 degrees of finger tracking, grasp force sensing, active force feedback on the fingers and vibrotactile feedback integrated in the fingertips and the palm, operators can control robotic hands effectively and with confidence. Supporting both direct control and imitation learning, R1 is a powerful interface for the next generation of tele-operation systems.

KEY FEATURES

ACTIVE FORCE FEEDBACK

The thumb, index finger, middle finger and ring finger feature Active Force Feedback (AFFB). The AFFB module can provide resistance on the operator's fingers, simulating the presence of a rigid object in the robot's grasp – as well as a pulling force on the fingers, simulating for example the restorative force of an elastic object compressed by the robot hand. The active force feedback can simulate the resistance of a firm grip.

VIBRATION FEEDBACK

Vibrotactile actuators are located in each fingertip (5) as well as in the palm of the hand (3). These vibration motors can make the operator feel the roughness or smoothness of the surface being explored by a robot hand. Additionally, they can be used to represent the tactile sensation of switches, power tools, light touches or UI cues.

PRECISION FINGER TRACKING

40 (5x8) rotary Hall effect sensors enable robust tracking of all five fingers, providing millimeter precision at the fingertips and along each phalanx.

FORCE SENSING

Each AFFB module is equipped with a force sensor, allowing for robot operation and imitation learning leveraging not only precise finger motion data, but also grasp force data. For optimal results, combine R1 gloves with robot hands featuring force sensing – either through current measurements or dedicated force sensors.

CONNECTIVITY

LINKBOX

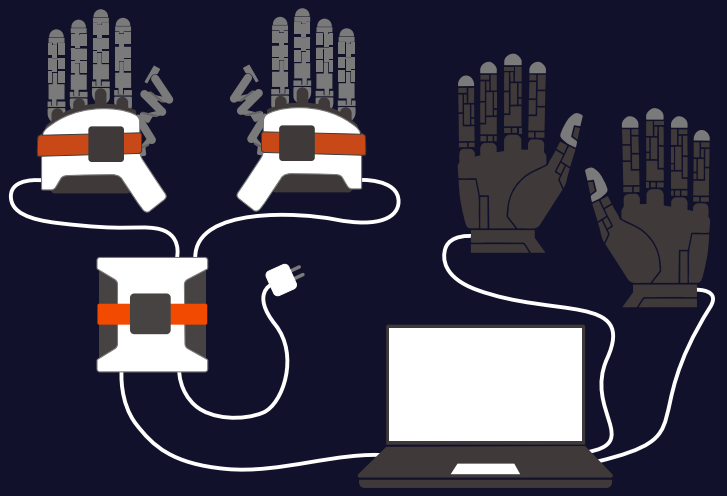
Two R1 gloves are connected to the wall socket and a PC through a linkbox (see image below). Using the R1 Python API and ROS 2 any robot hand can be controlled, provided proper glove-to-robot mapping exists.

MAPPING

Two main glove-to-robot mapping strategies are available:

- 1 DoF finger control (any robot hand)
- individual finger joint control (if supported by the robot hand)

Our dedicated algorithms remap glove tracking to robot hand values while maintaining accurate robot hand pinches.



TECHNICAL SPECIFICATIONS

PARAMETER		SPECIFICATION (PER GLOVE)
Sensors	**Position (fingers)**	40x ASM rotary position sensors; 8x per finger, located in each exoskeleton flexion/extension joint (7x) and in the ab-/adduction joint (1x) Resolution: 14-bit (0.0219°/LSB)
	Force (fingers)	4x Tekscan force sensors integrated in custom sensing assembly in the AFFB module Maximum measurable force: 20 N Sensing resolution: 0.01 N
	Orientation (hand)	1x Bosch Sensortec BNO055 IMU 9-axis absolute orientation sensor with triaxial accelerometer, gyroscope and magnetometer, with integrated sensor fusion
Actuators	**Active Force Feedback**	4x Active Force Feedback Module including motor, gearhead and custom pulley system for mechanical force transmission Motor: Faulhaber brushed DC motor Gearhead: 8:1 spur gearhead mounted on motor Mechanical time constant (motor): 6.8 ms No-load speed (motor): 5900 min-1 Maximum output torque (after gearhead, before pulley): Continuous operation: 9 mNm Intermittent operation: 30 mNm
	Vibrotactile feedback	8x Linear Resonant Actuators: 1x in each thimble, 3x in the palm of the hand Rise time max: 50 ms Fall time max: 100 ms Resonant frequency: 210 Hz Vibration force: min. 2.0 Gp at resonant frequency
Force transmission		Tendon-based system with pulley routing through articulated finger exoskeleton

Finger Tracking	40-DoF exoskeleton sensing (8 rotational measurements per finger across 5 fingers), providing the 6-DoF pose of each fingertip for real-time control of 20-DoF humanoid robot hands
Feedback Types	Force (4 fingers): 1 DOF active pulling force feedback Vibration (8 locations)
Microprocessor	Raspberry Pi RP2350B
Connection	USB-C via wired linkbox to PC (USB-A connector) and wall socket USB 2.0 with USB PD Max power draw: 45 W
Software Support	Python API (Python 3.8+) ROS 2
Glove Sizes	Swappable textile base glove in size Medium Sizes Small and Large will follow
Latency	R1-PC one-way latency: ~10 ms
FPS	Up to* 1 kHz for single glove Up to* 0.5 kHz for two gloves *depending on CPU specifications
Supported OS	Windows Linux systems GCC9 or newer
Weight	580 g per glove
Dimensions	Bounding box of 1 glove: 260 x 130 x 90 mm
Hand tracking	Built-in orientation tracking using IMU Mounting point for external tracking device

CHARACTERIZATION

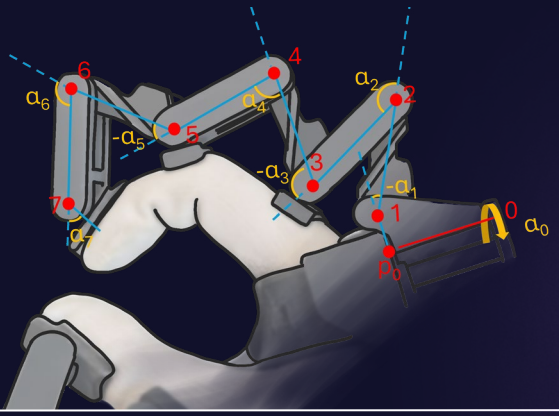
FINGER TRACKING DATA

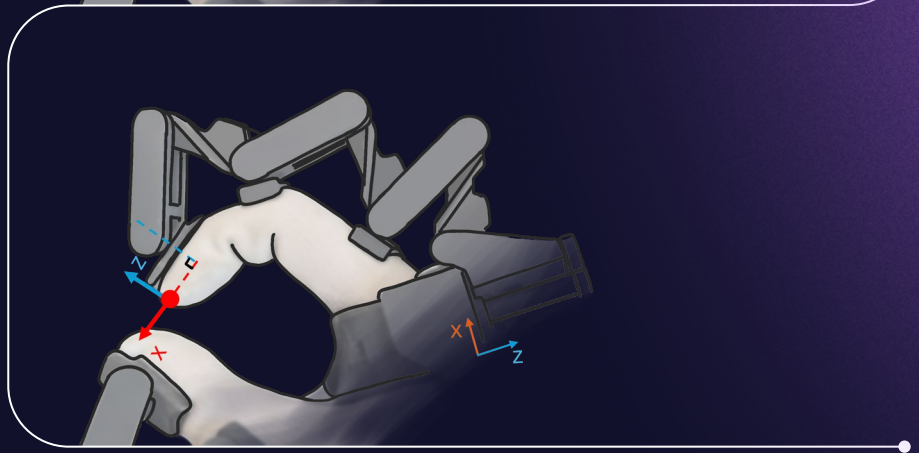
Each joint in the finger exoskeleton contains a rotary position sensor (see top image), allowing for mapping of the position and orientation of each exoskeleton linkage. Data can be retrieved from the R1 API in three different formats:

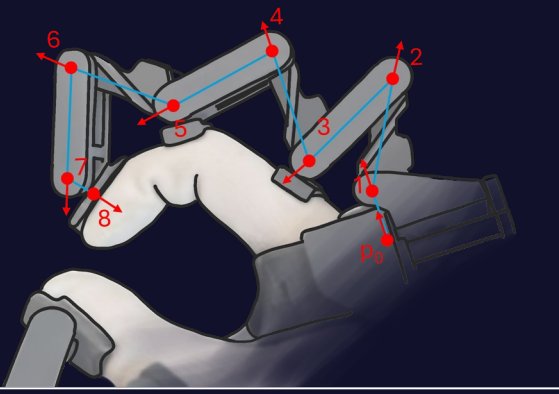
- The position and orientation of the fingertips (see middle image);
- The position and orientation of each exoskeleton linkage (see bottom image);
- A value called ‘percentage bent’ that is indicative of finger flexion where 0% means fully extended and 100% means fully flexed.

Average absolute error per joint	0,42°
Maximum error measured in a joint	3,0°
Maximum fingertip position error[1,2]	3 mm (fully extended fingers) 7 mm (fully flexed fingers)

1. When using our glove-to-robot mapper algorithm, these tracking errors are compensated for, resulting in extremely accurate pinches.
2. During use the exoskeleton linkages may undergo torsion, which can influence tracking accuracy. Such effects are not included in these values.







FORCE FEEDBACK

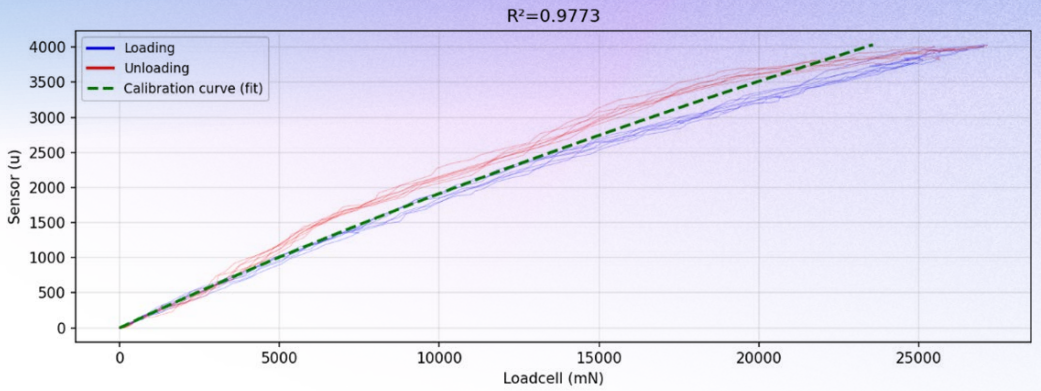
LIMITS	FORCE (N)*	CONTEXT
Minimum force	0.2 N / 20 g	Minimum force applied by the motor module to keep a slight tension on the cable
Maximum resistive force	25 N / 2.5 kg	The maximum force exerted by a finger that the motor module can resist
Maximum active force	3.5 N / 350 g	The maximum force the motor module can actively exert on the finger
Recommended minimum force goal	200 mN	Cannot be lower than the minimum force
Recommended maximum force goal	20000 mN	This will simulate a stiff object

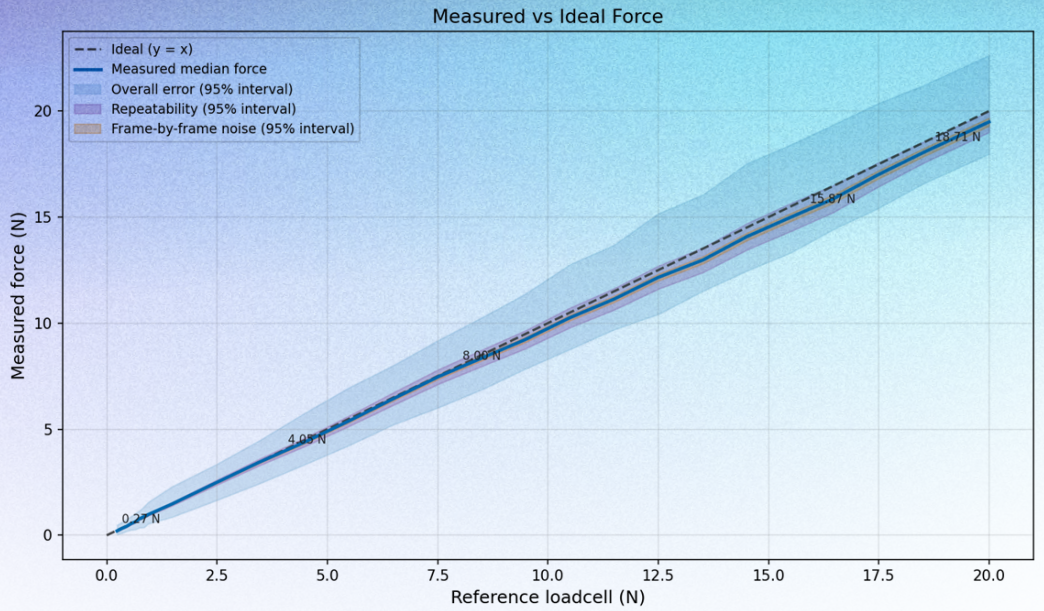
*The forces listed are tension forces in the force feedback cables. For fingertip forces in a stretched hand, the force on the fingertips is approximately half of this force, depending on hand size. In the flexed position, this factor becomes smaller. Conversion algorithms between tension force and fingertip force will be made available Q4 2026.

FORCE SENSING DATA

LIMITS		VALUE
Maximum measurable force		20 N
Absolute error*	Mean	0.9 N
	95% CI	2.6 N
Repeatability	Median	4.4%
	95% CI	+/- 13.3%
Frame-by-frame noise	Median	1.38%
	95% CI	+/- 4.1%
Sensor resolution (smallest detectable change)		0.01 N

*The absolute error is largely due to hysteresis and will consequently only occur as a measured deviation between increasing and decreasing pressure. When comparing multiple force ramp-ups, mean repeatability is 4.4%.



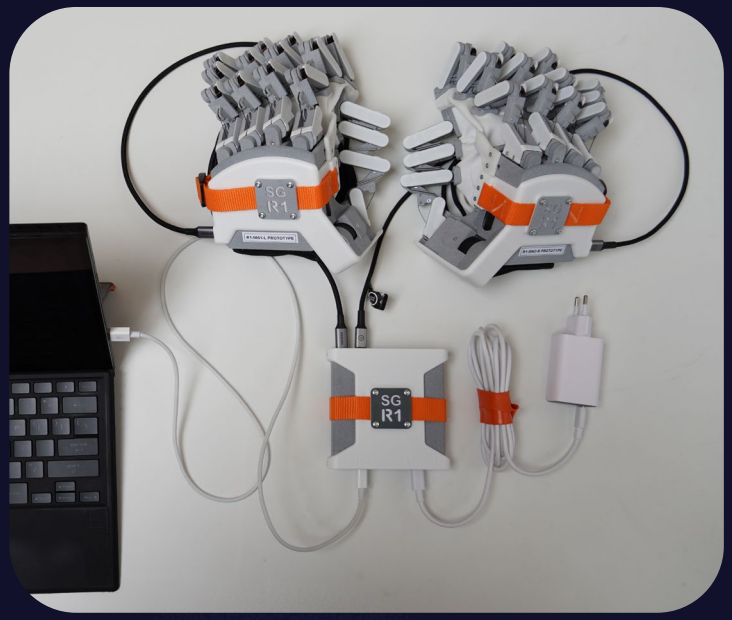


PRODUCT ORDER INFORMATION

INCLUDED IN PACKAGE:
1x Left R1 with Softglove
1x Right R1 with Softglove
1x Linkbox
1x USB Power Adapter
3x USB-C to C cable
1x USB-C to A cable
1x Left Mechanical Interface to Tracking Solution*
1x Right Mechanical Interface to Tracking Solution*
SDK access

*Currently available: mechanical interface to HTC Vive tracker

Pricing available upon request
Inquire for delivery timelines



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