Human Safety Fitness Metrics

Table 14: Variable Definitions

Variable	description	unit
$F_{\mathrm{s,z}}$	measured force	N
$F_{\mathrm{t,q}}$	quasi-static collision threshold[5]	N
$F_{\mathrm{t,t}}$	transient collision threshold[??]	N
m_{e}	effective mass (reflected inertia)	kg
m_{load}	additional mass loaded to the test device	kg
n_{d}	number of detected contacts	-
$n_{\mathrm{d,t}}$	number of detected contacts for tactile collision sensitivity	-
N_{c}	amount of conducted collision tests	-
$N_{\dot{\mathbf{x}}}$	total amount of velocity settings for the experiment	-
u	unit step function	-
$\dot{\mathbf{x}}$	velocity	$\mathrm{m/s}$
x_{s}	start point in Cartesian frame of the test device	mm
x_{e}	end point in Cartesian frame of the test device	mm

Table 15: Metric Definitions

Metric	name	description	eq.	unit	best[6]
$\mathrm{S_t}$	Conformance to transient collision thresholds	Percentage of velocity setting where the initial collision with a constrained body part complies to current thresholds	$\frac{n_{\mathrm{s,t}}}{N_{\mathrm{c}}}$, $n_{\mathrm{s,t}} = \sum_{i=1}^{N_{\mathrm{c}}} u\left(\frac{1}{\max_t F_{\mathrm{s,z}} - F_{\mathrm{t,t}}} - 1\right)$, $N_{\mathrm{c}} = N_{\mathrm{b}} N_{\dot{\mathbf{x}}}$	$\%$	100
$\mathrm{S_{qs}}$	Conformance to quasi-static collision thresholds	Percentage of velocity setting where is the clamping force after collision with a constrained body part complies to current thresholds	$\frac{n_{\mathrm{s,q}}}{N_{\mathrm{c}}}$, $n_{\mathrm{s,q}} = \sum_{i=1}^{N_{\mathrm{c}}} u\left(\frac{1}{\mu_{F_{\mathrm{s,z}}(t>0.5)} - F_{\mathrm{t,q}}} - 1\right)$	$\%$	100

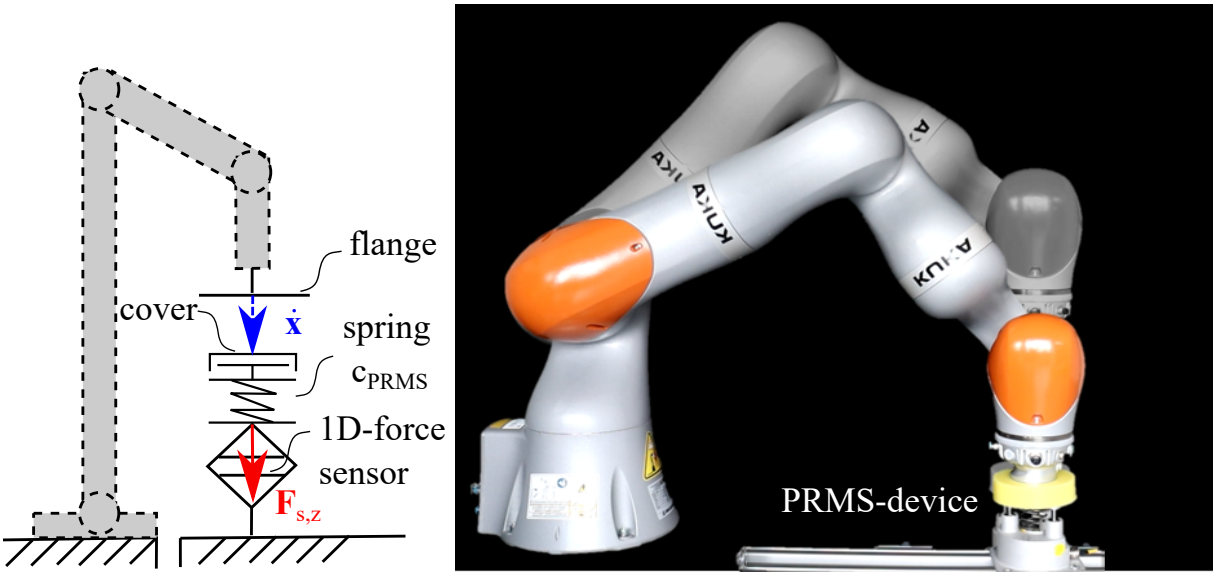

Figure 16: Reference system for constrained collision force measurement.

Table 16: Setup definitions

component	considered quantity	value	accuracy req.
contact velocities $\|\dot{\mathbf{x}}\|$	velocity $[\mathrm{m/s}]$	0.05	$\pm\,0.01$
		0.10	$\pm\,0.01$
		0.12	$\pm\,0.01$
		0.19	$\pm\,0.01$
		0.26	$\pm\,0.01$
		0.33	$\pm\,0.01$
		0.40	$\pm\,0.01$
		0.47	$\pm\,0.01$
		0.54	$\pm\,0.01$
device setting 1[7]	cover hardness [ShA]	70	-
	spring stiffness c_{PRMS} $[\mathrm{N/mm}]$	150	-
device setting 2	cover hardness [ShA]	70	-
	spring stiffness c_{PRMS} $[\mathrm{N/mm}]$	75	-
device setting 3	cover hardness [ShA]	30	-
	spring stiffness c_{PRMS} $[\mathrm{N/mm}]$	60	-
device setting 4	cover hardness [ShA]	30	-
	spring stiffness c_{PRMS} $[\mathrm{N/mm}]$	50	-
device setting 5	cover hardness [ShA]	70	-
	spring stiffness c_{PRMS} $[\mathrm{N/mm}]$	50	-
device setting 6	cover hardness [ShA]	70	-
	spring stiffness c_{PRMS} $[\mathrm{N/mm}]$	40	-
device setting 7	cover hardness [ShA]	30	-
	spring stiffness c_{PRMS} $[\mathrm{N/mm}]$	35	-
device setting 8	cover hardness [ShA]	30	-
	spring stiffness c_{PRMS} $[\mathrm{N/mm}]$	30	-
device setting 9	cover hardness [ShA]	70	-
	spring stiffness c_{PRMS} $[\mathrm{N/mm}]$	25	-
device setting 10	cover hardness [ShA]	10	-
	spring stiffness c_{PRMS} $[\mathrm{N/mm}]$	10	-
start distance x_{s}	distance $[\mathrm{mm}]$	[0,0,250]	$\pm\,2$
end distance x_{e}	distance $[\mathrm{mm}]$	[0,0,-250]	$\pm\,2$

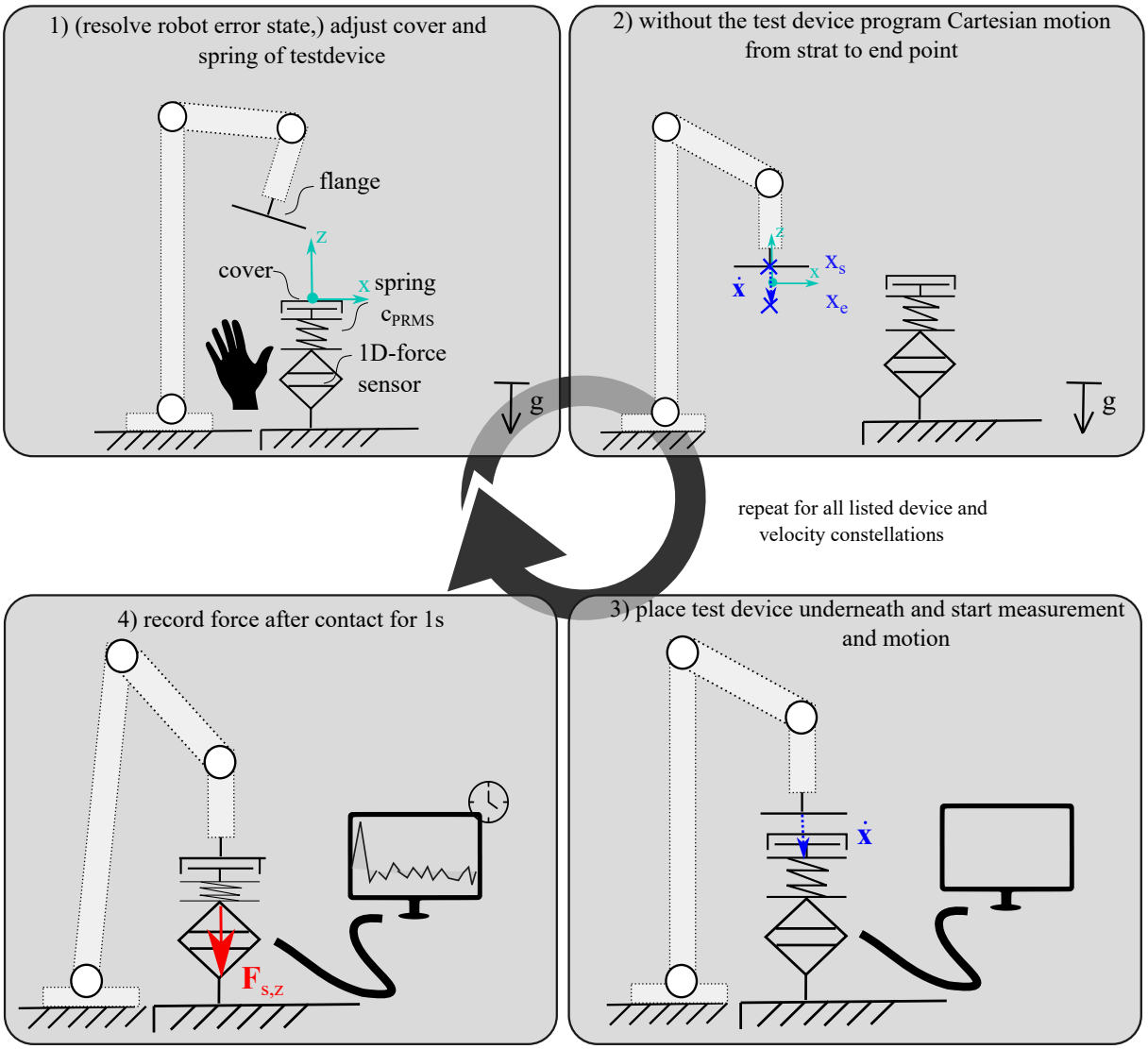

Figure 17: Measurement Procedure for S_{t} and S_{qs}.