Modeling friction and air effects between cloth and deformable bodies Suplemental Document

Zhili Chen Renguo Feng Huamin Wang

The Ohio State University

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Note 1: We use a FUTEK LSM250 load cell sensor to determine the friction force. The sensor measurement (in mV/V), calculated as the signal output (in mV) divided by the excitation voltage (in V), should be linearly promotional to the force magnitude. The excitation voltage depends on the power source and it is automatically adjusted by the sensor. We noticed that when a calibrated 200g weight is applied under the sensor, the measurement increases 2.488mV/V. So we calculate the *Coefficient of Friction* μ as:

$$\mu = \frac{s \cdot 200\mathrm{g}}{2.488\mathrm{mv/V}} \cdot \frac{1}{m_{\mathrm{total}}}, \tag{1}$$

in which s (in mV/V) is the sensor measurement and m_{total} (in g) is the sum of the cart weight and the additional weight.

We arrange our experiments for each sample pair as follows. We first fix the weight and measure the coefficients of friction three times in every direction: 0°, 45° and 90°. Then we calculate an $\mathrm{anisotropy}$ value as:

$$\mathrm{anisotropy} = \frac{\max(\mu_0, \mu_{45}, \mu_{90}) - \min(\mu_0, \mu_{45}, \mu_{90})}{\max(\mu_0, \mu_{45}, \mu_{90})}. \tag{2}$$

If this value is above 5%, we assume that the frictional behavior is anisotropic and we test the nonlinearity of the friction behavior in all of the three directions next. Otherwise, the friction behaviors is isotropic and we can test the nonlinearity in one direction only. Finally we calculate a $\mathrm{nonlinearity}$ value in a similar way to Equation 2, to indicate how nonlinear the result is.

Note 2: The cart moves at 0.01m per second during the experiment. The contact area between cloth and the deformable body is approximately 5cm $\times$10cm.

1 Plastic Foam

Cloth Material	Angle		Result					
			1	2	3	Mean	Std. Dev.	anisotropy
Royal Target (anisotropic)	0°	s	0.724	0.717	0.714			11.8%
		μ	0.565	0.560	0.557	0.561	0.0040	
	45°	s	0.678	0.663	0.678			
		μ	0.529	0.518	0.529	0.525	0.0064	
	90°	s	0.661	0.638	0.631			
		μ	0.516	0.498	0.493	0.502	0.0121	
White Dots On Black (isotropic)	0°	s	0.336	0.340	0.340			1.1%
		μ	0.262	0.265	0.265	0.264	0.0017	
	45°	s	0.330	0.338	0.334			
		μ	0.258	0.264	0.261	0.261	0.0030	
	90°	s	0.341	0.340	0.336			
		μ	0.266	0.265	0.262	0.264	0.0021	
Gray Interlock (isotropic)	0°	s	0.954	0.937	0.952			2.1%
		μ	0.745	0.731	0.743	0.740	0.0076	
	45°	s	0.930	0.927	0.927			
		μ	0.726	0.724	0.724	0.725	0.0012	
	90°	s	0.935	0.924	0.926			
		μ	0.730	0.721	0.723	0.725	0.0047	
Camel Ponte Roma (isotropic)	0°	s	0.741	0.739	0.724			0.9%
		μ	0.578	0.577	0.565	0.573	0.0072	
	45°	s	0.742	0.727	0.731			
		μ	0.579	0.567	0.571	0.572	0.0061	
	90°	s	0.744	0.736	0.736			
		μ	0.581	0.575	0.575	0.577	0.0035	
Pink Ribbon Brown (isotropic)	0°	s	0.838	0.843	0.828			0.6%
		μ	0.654	0.658	0.646	0.653	0.0061	
	45°	s	0.837	0.847	0.817			
		μ	0.653	0.661	0.638	0.651	0.0117	
	90°	s	0.839	0.838	0.839			
		μ	0.655	0.654	0.655	0.655	0.0006	
Ivory Rib Knit (isotropic)	0°	s	0.754	0.741	0.731			1.4%
		μ	0.589	0.578	0.571	0.579	0.0091	
	45°	s	0.744	0.734	0.718			
		μ	0.581	0.573	0.560	0.571	0.0106	
	90°	s	0.741	0.746	0.732			
		μ	0.578	0.582	0.571	0.577	0.0056	
White Swim Solid (anisotropic)	0°	s	0.450	0.456	0.454			16.7%
		μ	0.351	0.356	0.354	0.354	0.0025	
	45°	s	0.484	0.490	0.489			
		μ	0.378	0.382	0.382	0.381	0.0023	
	90°	s	0.530	0.529	0.526			
		μ	0.414	0.413	0.411	0.413	0.0015	
Black Denim (isotropic)	0°	s	0.782	0.775	0.771			1.2%
		μ	0.610	0.605	0.602	0.606	0.0040	
	45°	s	0.789	0.764	0.757			
		μ	0.616	0.596	0.591	0.601	0.0132	
	90°	s	0.769	0.771	0.761			
		μ	0.600	0.602	0.594	0.599	0.0042	
Navy Sparkle Sweat (isotropic)	0°	s	0.570	0.573	0.583			1.8%
		μ	0.445	0.447	0.455	0.449	0.0053	
	45°	s	0.580	0.567	0.564			
		μ	0.453	0.443	0.440	0.445	0.0068	
	90°	s	0.569	0.566	0.560			
		μ	0.444	0.442	0.437	0.441	0.0036	
Tango Red Jet Set (anisotropic)	0°	s	0.684	0.682	0.665			19.7%
		μ	0.534	0.532	0.519	0.528	0.0081	
	45°	s	0.635	0.643	0.629			
		μ	0.496	0.502	0.491	0.496	0.0055	
	90°	s	0.580	0.560	0.555			
		μ	0.453	0.437	0.433	0.441	0.0106	

Table 1: *Anisotropy test. The cart weight is 3.0g and the additional weight is 100.0g.*

Cloth Material	Angle		Result						
			10g	25g	50g	100g	200g	300g	nonlinearity
Royal Target (nonlinear)	0°	s	0.118	0.242	0.415	0.718	1.227	1.764	
		μ	0.730	0.695	0.630	0.560	0.486	0.468	56.0%
	45°	s	0.113	0.235	0.396	0.679	1.196	1.701	
		μ	0.699	0.675	0.601	0.530	0.474	0.451	55.0%
	90°	s	0.111	0.222	0.371	0.651	1.135	1.621	
		μ	0.686	0.637	0.563	0.508	0.450	0.430	59.5%
White Dots On Black (linear)	45°	s	0.041	0.092	0.166	0.333	0.636	0.958	
		μ	0.254	0.264	0.252	0.260	0.252	0.254	4.8%
Gray Interlock (nonlinear)	45°	s	0.181	0.346	0.558	0.931	1.585	2.245	
		μ	1.119	0.994	0.846	0.727	0.628	0.596	87.8%
Camel Ponte Roma (nonlinear)	45°	s	0.116	0.244	0.425	0.736	1.229	1.739	
		μ	0.717	0.701	0.645	0.575	0.487	0.461	55.5%
Pink Ribbon Brown (nonlinear)	45°	s	0.140	0.270	0.464	0.833	1.446	2.003	
		μ	0.866	0.775	0.704	0.650	0.573	0.531	63.1%
Ivory Rib Knit (nonlinear)	45°	s	0.126	0.242	0.418	0.739	1.298	1.854	
		μ	0.779	0.695	0.634	0.577	0.514	0.492	58.3%
White Swim Solid (linear)	0°	s	0.057	0.122	0.230	0.454	0.902	1.338	
		μ	0.353	0.350	0.349	0.354	0.357	0.355	2.3%
	45°	s	0.065	0.139	0.258	0.485	0.966	1.435	
		μ	0.402	0.399	0.391	0.379	0.383	0.381	6.1%
	90°	s	0.071	0.144	0.270	0.531	1.044	1.547	
		μ	0.439	0.413	0.410	0.414	0.413	0.410	7.1%
Black Denim (nonlinear)	45°	s	0.116	0.237	0.425	0.769	1.326	1.882	
		μ	0.717	0.681	0.645	0.600	0.525	0.499	43.7%
Navy Sparkle Sweat (nonlinear)	45°	s	0.075	0.165	0.305	0.579	1.056	1.511	
		μ	0.464	0.474	0.463	0.452	0.418	0.401	18.2%
Tango Red Jet Set (linear)	0°	s	0.092	0.193	0.355	0.683	1.330	1.953	
		μ	0.569	0.554	0.539	0.533	0.527	0.518	9.8%
	45°	s	0.084	0.177	0.322	0.621	1.188	1.753	
		μ	0.520	0.508	0.488	0.485	0.471	0.465	11.8%
	90°	s	0.073	0.159	0.297	0.561	1.096	1.613	
		μ	0.451	0.457	0.451	0.438	0.434	0.428	6.8%

Table 2: *Nonlinearity Test. The cart weight is 3.0g.*

2 Raw Sheepskin

Cloth Material	Angle		Result					
			1	2	3	Mean	Std. Dev.	anisotropy
Royal Target (isotropic)	0°	s	1.411	1.416	1.429			1.7%
		μ	1.048	1.051	1.061	1.053	0.0068	
	45°	s	1.371	1.406	1.403			
		μ	1.018	1.044	1.042	1.035	0.0145	
	90°	s	1.423	1.413	1.404			
		μ	1.056	1.049	1.042	1.049	0.0070	
White Dots On Black (isotropic)	0°	s	1.371	1.373	1.383			1.6%
		μ	1.018	1.019	1.027	1.021	0.0049	
	45°	s	1.359	1.353	1.351			
		μ	1.009	1.004	1.003	1.005	0.0032	
	90°	s	1.364	1.360	1.354			
		μ	1.013	1.010	1.005	1.009	0.0040	
Gray Interlock (isotropic)	0°	s	1.627	1.605	1.604			0.8%
		μ	1.208	1.192	1.191	1.197	0.0095	
	45°	s	1.605	1.602	1.588			
		μ	1.192	1.189	1.179	1.187	0.0068	
	90°	s	1.607	1.595	1.607			
		μ	1.193	1.184	1.193	1.190	0.0052	
Camel Ponte Roma (isotropic)	0°	s	1.633	1.612	1.630			2.9%
		μ	1.212	1.197	1.210	1.206	0.0081	
	45°	s	1.638	1.646	1.643			
		μ	1.216	1.222	1.220	1.219	0.0031	
	90°	s	1.590	1.610	1.588			
		μ	1.180	1.195	1.179	1.185	0.0090	
Pink Ribbon Brown (isotropic)	0°	s	1.472	1.486	1.461			1.0%
		μ	1.093	1.103	1.085	1.094	0.0090	
	45°	s	1.458	1.469	1.448			
		μ	1.082	1.091	1.075	1.083	0.0080	
	90°	s	1.469	1.455	1.457			
		μ	1.091	1.080	1.082	1.084	0.0059	
Ivory Rib Knit (isotropic)	0°	s	1.126	1.131	1.102			4.7%
		μ	0.836	0.840	0.818	0.831	0.0117	
	45°	s	1.128	1.086	1.134			
		μ	0.837	0.806	0.842	0.828	0.0195	
	90°	s	1.070	1.070	1.071			
		μ	0.794	0.794	0.795	0.794	0.0006	
White Swim Solid (anisotropic)	0°	s	0.953	0.946	0.943			14.4%
		μ	0.707	0.702	0.700	0.703	0.0036	
	45°	s	1.014	1.005	1.010			
		μ	0.753	0.746	0.750	0.750	0.0035	
	90°	s	1.084	1.090	1.073			
		μ	0.805	0.809	0.797	0.804	0.0061	
Black Denim (isotropic)	0°	s	1.313	1.316	1.309			2.7%
		μ	0.975	0.977	0.972	0.975	0.0025	
	45°	s	1.315	1.315	1.333			
		μ	0.976	0.976	0.990	0.981	0.0081	
	90°	s	1.343	1.350	1.351			
		μ	0.997	1.002	1.003	1.001	0.0032	
Navy Sparkle Sweat (isotropic)	0°	s	1.323	1.329	1.349			2.8%
		μ	0.982	0.987	1.001	0.990	0.0098	
	45°	s	1.339	1.330	1.301			
		μ	0.994	0.987	0.966	0.982	0.0146	
	90°	s	1.301	1.288	1.301			
		μ	0.966	0.956	0.966	0.963	0.0058	
Tango Red Jet Set (anisotropic)	0°	s	1.180	1.176	1.156			23.6%
		μ	0.876	0.873	0.858	0.869	0.0096	
	45°	s	1.068	1.088	1.075			
		μ	0.793	0.808	0.798	0.800	0.0076	
	90°	s	0.949	0.939	0.954			
		μ	0.705	0.697	0.708	0.703	0.0057	

Table 3: *Anisotropy test. The cart weight is 8.3g and the additional weight is 100.0g.*

Cloth Material	Angle		Result							
			10g	25g	50g	75g	100g	150g	200g	nonlinearity
Royal Target (nonlinear)	45°	s	0.387	0.584	0.883	1.138	1.396	1.906	2.440	
		μ	1.700	1.410	1.218	1.098	1.036	0.968	0.942	80.5%
White Dots On Black (nonlinear)	45°	s	0.342	0.517	0.807	1.086	1.348	1.856	2.349	
		μ	1.503	1.248	1.113	1.048	1.001	0.943	0.907	65.7%
Gray Interlock (nonlinear)	45°	s	0.432	0.643	0.981	1.289	1.591	2.161	-	
		μ	1.898	1.552	1.353	1.244	1.181	1.098	-	72.9%
Camel Ponte Roma (nonlinear)	45°	s	0.436	0.651	0.991	1.321	1.640	2.248	-	
		μ	1.916	1.572	1.367	1.275	1.218	1.142	-	67.8%
Pink Ribbon Brown (nonlinear)	45°	s	0.348	0.542	0.868	1.173	1.463	1.984	-	
		μ	1.529	1.309	1.197	1.132	1.086	1.008	-	51.7%
Ivory Rib Knit (nonlinear)	45°	s	0.350	0.511	0.726	0.925	1.134	1.489	1.794	
		μ	1.538	1.234	1.001	0.893	0.842	0.756	0.692	122.3%
White Swim Solid (nonlinear)	0°	s	0.220	0.349	0.553	0.759	0.950	1.376	1.766	
		μ	0.967	0.843	0.763	0.733	0.705	0.699	0.682	41.8%
	45°	s	0.241	0.376	0.603	0.814	1.007	1.414	1.792	
		μ	1.059	0.908	0.832	0.786	0.748	0.718	0.692	53.0%
	90°	s	0.287	0.423	0.639	0.855	1.075	1.483	1.874	
		μ	1.261	1.021	0.881	0.825	0.798	0.753	0.723	74.4%
Black Denim (nonlinear)	45°	s	0.322	0.510	0.802	1.082	1.328	1.815	2.316	
		μ	1.415	1.231	1.106	1.044	0.986	0.922	0.894	58.3%
Navy Sparkle Sweat (nonlinear)	45°	s	0.311	0.488	0.777	1.062	1.334	1.863	2.415	
		μ	1.366	1.178	1.072	1.025	0.990	0.946	0.932	46.6%
Tango Red Jet Set (nonlinear)	0°	s	0.248	0.408	0.658	0.902	1.170	1.673	2.190	
		μ	1.090	0.985	0.907	0.871	0.869	0.850	0.845	29.0%
	45°	s	0.215	0.362	0.597	0.825	1.069	1.526	1.971	
		μ	0.945	0.874	0.823	0.796	0.794	0.775	0.761	24.2%
	90°	s	0.181	0.313	0.522	0.737	0.950	1.387	1.805	
		μ	0.795	0.756	0.720	0.711	0.705	0.704	0.697	14.1%

Table 4: *Nonlinearity Test. The cart weight is 8.3g.*

3 Waxed Sheepskin

Cloth Material	Angle		Result					
			1	2	3	Mean	Std. Dev.	anisotropy
Royal Target (isotropic)	0°	s	0.689	0.681	0.675			3.0%
		μ	0.269	0.265	0.263	0.266	0.0031	
	45°	s	0.707	0.702	0.699			
		μ	0.276	0.274	0.272	0.274	0.0020	
	90°	s	0.708	0.698	0.696			
		μ	0.276	0.272	0.271	0.273	0.0026	
White Dots On Black (isotropic)	0°	s	0.707	0.701	0.699			0.4%
		μ	0.276	0.273	0.272	0.274	0.0021	
	45°	s	0.706	0.700	0.699			
		μ	0.275	0.273	0.272	0.273	0.0015	
	90°	s	0.705	0.700	0.695			
		μ	0.275	0.273	0.271	0.273	0.0020	
Gray Interlock (isotropic)	0°	s	0.731	0.715	0.709			2.6%
		μ	0.285	0.279	0.276	0.280	0.0046	
	45°	s	0.718	0.703	0.696			
		μ	0.280	0.274	0.271	0.275	0.0046	
	90°	s	0.715	0.699	0.689			
		μ	0.279	0.272	0.269	0.273	0.0051	
Camel Ponte Roma (isotropic)	0°	s	0.665	0.659	0.655			0.8%
		μ	0.259	0.257	0.255	0.257	0.0020	
	45°	s	0.659	0.656	0.655			
		μ	0.257	0.256	0.255	0.256	0.0010	
	90°	s	0.664	0.661	0.659			
		μ	0.259	0.258	0.257	0.258	0.0010	
Pink Ribbon Brown (isotropic)	0°	s	0.715	0.706	0.701			3.8%
		μ	0.279	0.275	0.273	0.276	0.0031	
	45°	s	0.704	0.699	0.696			
		μ	0.274	0.272	0.271	0.272	0.0015	
	90°	s	0.692	0.678	0.675			
		μ	0.270	0.264	0.263	0.266	0.0038	
Ivory Rib Knit (isotropic)	0°	s	0.699	0.706	0.701			3.0%
		μ	0.272	0.275	0.273	0.273	0.0015	
	45°	s	0.689	0.679	0.671			
		μ	0.269	0.265	0.262	0.265	0.0035	
	90°	s	0.697	0.699	0.689			
		μ	0.272	0.272	0.269	0.271	0.0017	
White Swim Solid (isotropic)	0°	s	0.613	0.609	0.610			3.5%
		μ	0.239	0.237	0.238	0.238	0.0010	
	45°	s	0.591	0.591	0.590			
		μ	0.230	0.230	0.230	0.230	0.0000	
	90°	s	0.596	0.587	0.586			
		μ	0.232	0.229	0.228	0.230	0.0021	
Black Denim (isotropic)	0°	s	0.647	0.639	0.640			0.4%
		μ	0.252	0.249	0.249	0.250	0.0017	
	45°	s	0.647	0.638	0.636			
		μ	0.252	0.249	0.248	0.250	0.0021	
	90°	s	0.644	0.637	0.634			
		μ	0.251	0.248	0.247	0.249	0.0021	
Navy Sparkle Sweat (isotropic)	0°	s	0.654	0.654	0.655			4.3%
		μ	0.255	0.255	0.255	0.255	0.0000	
	45°	s	0.679	0.667	0.663			
		μ	0.265	0.260	0.258	0.261	0.0036	
	90°	s	0.675	0.686	0.686			
		μ	0.263	0.267	0.267	0.266	0.0023	
Tango Red Jet Set (isotropic)	0°	s	0.676	0.671	0.666			1.1%
		μ	0.263	0.262	0.260	0.262	0.0015	
	45°	s	0.678	0.681	0.679			
		μ	0.264	0.265	0.265	0.265	0.0006	
	90°	s	0.677	0.676	0.670			
		μ	0.264	0.263	0.261	0.263	0.0015	

Table 5: *Anisotropy test. The cart weight is 6.3g and the additional weight is 200.0g.*

Cloth Material	Angle		Result						
			10g	25g	50g	100g	200g	300g	nonlinearity
Royal Target (linear)	45°	s	0.055	0.105	0.190	0.358	0.695	1.036	
		μ	0.271	0.270	0.271	0.271	0.271	0.272	0.7%
White Dots On Black (linear)	45°	s	0.054	0.103	0.188	0.357	0.697	1.037	
		μ	0.266	0.265	0.268	0.270	0.272	0.272	2.6%
Gray Interlock (nonlinear)	45°	s	0.063	0.116	0.200	0.372	0.702	1.029	
		μ	0.311	0.298	0.286	0.281	0.274	0.270	15.2%
Camel Ponte Roma (nonlinear)	45°	s	0.058	0.110	0.194	0.353	0.655	0.953	
		μ	0.286	0.283	0.277	0.267	0.255	0.250	14.4%
Pink Ribbon Brown (nonlinear)	45°	s	0.071	0.122	0.206	0.372	0.695	1.028	
		μ	0.350	0.313	0.294	0.281	0.271	0.270	29.6%
Ivory Rib Knit (nonlinear)	45°	s	0.062	0.114	0.199	0.365	0.680	1.004	
		μ	0.306	0.293	0.284	0.276	0.265	0.264	15.9%
White Swim Solid (nonlinear)	45°	s	0.053	0.098	0.167	0.305	0.594	0.869	
		μ	0.261	0.252	0.238	0.231	0.231	0.228	14.5%
Black Denim (linear)	45°	s	0.055	0.103	0.181	0.336	0.635	0.940	
		μ	0.271	0.265	0.258	0.254	0.247	0.247	9.7%
Navy Sparkle Sweat (linear)	45°	s	0.054	0.104	0.183	0.340	0.662	0.973	
		μ	0.266	0.267	0.261	0.257	0.258	0.255	4.7%
Tango Red Jet Set (linear)	45°	s	0.052	0.101	0.185	0.347	0.676	1.008	
		μ	0.256	0.259	0.264	0.262	0.263	0.265	3.5%

Table 6: *Nonlinearity test. The cart weight is 6.3g.*

4 Cotton

Cloth Material	Angle		Result					
			1	2	3	Mean	Std. Dev.	anisotropy
Royal Target (isotropic)	0°	s	1.318	1.318	1.331			1.0%
		μ	1.009	1.009	1.019	1.012	0.0058	
	45°	s	1.314	1.315	1.334			
		μ	1.006	1.007	1.021	1.011	0.0084	
	90°	s	1.340	1.332	1.330			
		μ	1.026	1.020	1.018	1.021	0.0042	
White Dots On Black (isotropic)	0°	s	0.870	0.880	0.873			0.1%
		μ	0.666	0.674	0.668	0.669	0.0042	
	45°	s	0.878	0.871	0.876			
		μ	0.672	0.667	0.671	0.670	0.0026	
	90°	s	0.871	0.877	0.875			
		μ	0.667	0.672	0.670	0.670	0.0025	
Gray Interlock (isotropic)	0°	s	1.075	1.069	1.069			0.5%
		μ	0.823	0.819	0.819	0.820	0.0023	
	45°	s	1.068	1.088	1.073			
		μ	0.818	0.833	0.822	0.824	0.0078	
	90°	s	1.076	1.069	1.069			
		μ	0.824	0.819	0.819	0.821	0.0029	
Camel Ponte Roma (isotropic)	0°	s	0.960	0.956	0.954			2.3%
		μ	0.735	0.732	0.730	0.732	0.0025	
	45°	s	0.946	0.952	0.952			
		μ	0.724	0.729	0.729	0.727	0.0029	
	90°	s	0.970	0.974	0.971			
		μ	0.743	0.746	0.744	0.744	0.0015	
Pink Ribbon Brown (isotropic)	0°	s	1.106	1.102	1.086			2.8%
		μ	0.847	0.844	0.832	0.841	0.0079	
	45°	s	1.075	1.079	1.078			
		μ	0.823	0.826	0.825	0.825	0.0015	
	90°	s	1.072	1.063	1.068			
		μ	0.821	0.814	0.818	0.818	0.0035	
Ivory Rib Knit (isotropic)	0°	s	1.061	1.063	1.059			2.0%
		μ	0.812	0.814	0.811	0.812	0.0015	
	45°	s	1.063	1.055	1.054			
		μ	0.814	0.808	0.807	0.810	0.0038	
	90°	s	1.046	1.032	1.042			
		μ	0.801	0.790	0.798	0.796	0.0057	
White Swim Solid (anisotropic)	0°	s	0.534	0.536	0.536			16.1%
		μ	0.409	0.410	0.410	0.410	0.0006	
	45°	s	0.576	0.575	0.575			
		μ	0.441	0.440	0.440	0.440	0.0006	
	90°	s	0.621	0.622	0.620			
		μ	0.476	0.476	0.475	0.476	0.0006	
Black Denim (isotropic)	0°	s	1.029	1.020	1.016			1.0%
		μ	0.788	0.781	0.778	0.782	0.0051	
	45°	s	1.027	1.018	1.013			
		μ	0.786	0.779	0.776	0.780	0.0051	
	90°	s	1.005	1.012	1.013			
		μ	0.770	0.775	0.776	0.774	0.0032	
Navy Sparkle Sweat (isotropic)	0°	s	0.900	0.912	0.897			3.1%
		μ	0.689	0.698	0.687	0.691	0.0059	
	45°	s	0.882	0.878	0.876			
		μ	0.675	0.672	0.671	0.673	0.0021	
	90°	s	0.872	0.875	0.877			
		μ	0.668	0.670	0.672	0.670	0.0020	
Tango Red Jet Set (anisotropic)	0°	s	0.682	0.682	0.680			32.0%
		μ	0.522	0.522	0.521	0.522	0.0006	
	45°	s	0.791	0.789	0.788			
		μ	0.606	0.604	0.603	0.604	0.0015	
	90°	s	0.899	0.901	0.901			
		μ	0.688	0.690	0.690	0.689	0.0012	

Table 7: *Anisotropy test. The cart weight is 5.0g and the additional weight is 100.0g.*

Cloth Material	Angle		Result								
			10g	25g	50g	75g	100g	150g	200g	300g	nonlinearity
Royal Target (nonlinear)	45°	s	0.276	0.481	0.784	1.064	1.314	1.783	2.204	-	
		μ	1.479	1.289	1.146	1.069	1.006	0.925	0.864	-	71.2%
White Dots On Black (nonlinear)	45°	s	0.210	0.346	0.544	0.723	0.881	1.183	1.459	1.990	
		μ	1.126	0.927	0.795	0.727	0.675	0.614	0.572	0.525	114.5%
Gray Interlock (nonlinear)	45°	s	0.251	0.426	0.671	0.888	1.069	1.415	1.695	-	
		μ	1.345	1.142	0.981	0.892	0.819	0.734	0.665	-	102.3%
Camel Ponte Roma (nonlinear)	45°	s	0.227	0.373	0.595	0.781	0.955	1.285	1.592	2.126	
		μ	1.217	1.000	0.870	0.785	0.731	0.667	0.624	0.560	117.3%
Pink Ribbon Brown (nonlinear)	45°	s	0.276	0.454	0.681	0.889	1.073	1.426	1.718	-	
		μ	1.479	1.217	0.995	0.893	0.822	0.740	0.674	-	119.4%
Ivory Rib Knit (nonlinear)	45°	s	0.250	0.430	0.653	0.860	1.056	1.415	1.714	-	
		μ	1.340	1.152	0.955	0.864	0.809	0.734	0.672	-	99.4%
White Swim Solid (nonlinear)	0°	s	0.101	0.183	0.309	0.423	0.533	0.731	0.932	1.306	
		μ	0.541	0.490	0.452	0.425	0.408	0.379	0.366	0.344	57.3%
	45°	s	0.100	0.190	0.323	0.453	0.575	0.804	1.034	1.496	
		μ	0.536	0.509	0.472	0.455	0.440	0.417	0.406	0.394	36.0%
	90°	s	0.125	0.214	0.349	0.487	0.619	0.884	1.124	1.597	
		μ	0.670	0.574	0.510	0.489	0.474	0.459	0.441	0.421	59.1%
Black Denim (nonlinear)	45°	s	0.240	0.402	0.619	0.820	1.013	1.377	1.691	2.292	
		μ	1.286	1.077	0.905	0.824	0.776	0.714	0.663	0.604	112.9%
Navy Sparkle Sweat (nonlinear)	45°	s	0.220	0.357	0.543	0.709	0.871	1.159	1.435	1.947	
		μ	1.179	0.957	0.794	0.713	0.667	0.601	0.563	0.513	129.8%
Tango Red Jet Set (nonlinear)	0°	s	0.140	0.251	0.402	0.541	0.679	0.930	1.175	1.649	
		μ	0.750	0.673	0.588	0.544	0.520	0.482	0.461	0.435	72.4%
	45°	s	0.160	0.288	0.475	0.628	0.787	1.085	1.358	1.902	
		μ	0.858	0.772	0.694	0.631	0.603	0.563	0.533	0.501	71.3%
	90°	s	0.183	0.333	0.538	0.722	0.901	1.233	1.544	2.149	
		μ	0.981	0.892	0.786	0.726	0.690	0.640	0.606	0.566	73.3%

Table 8: *Nonlinearity test. The cart weight is 5.0g.*

5 Sponge

Cloth Material	Angle		Result					
			1	2	3	Mean	Std. Dev.	anisotropy
Royal Target (anisotropic)	0°	s	1.189	1.189	1.184			16.3%
		μ	0.915	0.915	0.911	0.914	0.0023	
	45°	s	1.118	1.115	1.106			
		μ	0.860	0.858	0.851	0.856	0.0047	
	90°	s	1.020	1.022	1.021			
		μ	0.785	0.786	0.786	0.786	0.0006	
White Dots On Black (isotropic)	0°	s	1.361	1.354	1.377			1.7%
		μ	1.047	1.042	1.059	1.049	0.0087	
	45°	s	1.387	1.386	1.388			
		μ	1.067	1.066	1.068	1.067	0.0010	
	90°	s	1.380	1.392	1.390			
		μ	1.062	1.071	1.069	1.067	0.0047	
Gray Interlock (isotropic)	0°	s	1.716	1.722	1.719			2.1%
		μ	1.320	1.325	1.323	1.323	0.0025	
	45°	s	1.735	1.750	1.737			
		μ	1.335	1.346	1.336	1.339	0.0061	
	90°	s	1.756	1.756	1.755			
		μ	1.351	1.351	1.350	1.351	0.0006	
Camel Ponte Roma (isotropic)	0°	s	1.423	1.415	1.412			2.5%
		μ	1.095	1.089	1.086	1.090	0.0046	
	45°	s	1.399	1.400	1.394			
		μ	1.076	1.077	1.073	1.075	0.0021	
	90°	s	1.380	1.384	1.382			
		μ	1.062	1.065	1.063	1.063	0.0015	
Pink Ribbon Brown (isotropic)	0°	s	1.793	1.790	1.788			2.6%
		μ	1.379	1.377	1.376	1.377	0.0015	
	45°	s	1.790	1.783	1.785			
		μ	1.377	1.372	1.373	1.374	0.0026	
	90°	s	1.836	1.835	1.828			
		μ	1.413	1.412	1.406	1.410	0.0038	
Ivory Rib Knit (isotropic)	0°	s	1.440	1.432	1.439			1.3%
		μ	1.108	1.102	1.107	1.106	0.0032	
	45°	s	1.429	1.421	1.419			
		μ	1.099	1.093	1.092	1.095	0.0038	
	90°	s	1.452	1.436	1.437			
		μ	1.117	1.105	1.106	1.109	0.0067	
White Swim Solid (anisotropic)	0°	s	0.995	0.985	1.002			30.1%
		μ	0.766	0.758	0.771	0.765	0.0066	
	45°	s	1.134	1.141	1.137			
		μ	0.872	0.878	0.875	0.875	0.0030	
	90°	s	1.300	1.291	1.289			
		μ	1.000	0.993	0.992	0.995	0.0044	
Black Denim (isotropic)	0°	s	1.320	1.322	1.305			3.4%
		μ	1.016	1.017	1.004	1.012	0.0072	
	45°	s	1.293	1.292	1.287			
		μ	0.995	0.994	0.990	0.993	0.0026	
	90°	s	1.273	1.272	1.274			
		μ	0.979	0.979	0.980	0.979	0.0006	
Navy Sparkle Sweat (isotropic)	0°	s	2.253	2.254	2.270			3.2%
		μ	1.733	1.734	1.746	1.738	0.0072	
	45°	s	2.189	2.187	2.191			
		μ	1.684	1.683	1.686	1.684	0.0015	
	90°	s	2.230	2.235	2.242			
		μ	1.716	1.720	1.725	1.720	0.0045	
Tango Red Jet Set (anisotropic)	0°	s	1.306	1.305	1.309			22.9%
		μ	1.005	1.004	1.007	1.005	0.0015	
	45°	s	1.200	1.185	1.182			
		μ	0.923	0.912	0.909	0.915	0.0074	
	90°	s	1.060	1.064	1.064			
		μ	0.816	0.819	0.819	0.818	0.0017	

Table 9: *Anisotropy test. The cart weight is 4.5g and the additional weight is 100.0g.*

Cloth Material	Angle		Result							
			10g	25g	50g	75g	100g	150g	200g	nonlinearity
Royal Target (nonlinear)	0°	s	0.225	0.422	0.706	0.957	1.183	1.640	2.085	
		μ	1.248	1.150	1.042	0.968	0.910	0.853	0.820	52.2%
	45°	s	0.198	0.365	0.616	0.864	1.107	1.557	1.989	
		μ	1.098	0.995	0.909	0.874	0.852	0.810	0.782	40.4%
	90°	s	0.164	0.320	0.555	0.788	1.023	1.467	1.905	
		μ	0.909	0.872	0.819	0.797	0.787	0.763	0.749	21.4%
White Dots On Black (nonlinear)	45°	s	0.270	0.477	0.798	1.099	1.384	1.942	2.451	
		μ	1.497	1.300	1.177	1.111	1.065	1.011	0.964	55.3%
Gray Interlock (nonlinear)	45°	s	0.433	0.740	1.097	1.432	1.741	2.356	-	
		μ	2.401	2.017	1.618	1.448	1.339	1.226	-	95.8%
Camel Ponte Roma (nonlinear)	45°	s	0.335	0.557	0.872	1.143	1.398	1.854	2.295	
		μ	1.858	1.518	1.286	1.156	1.076	0.965	0.902	106.0%
Pink Ribbon Brown (nonlinear)	45°	s	0.349	0.638	1.056	1.434	1.785	2.467	-	
		μ	1.935	1.739	1.558	1.450	1.373	1.284	-	50.70%
Ivory Rib Knit (nonlinear)	45°	s	0.320	0.528	0.848	1.148	1.425	1.941	2.464	
		μ	1.774	1.439	1.251	1.161	1.096	1.010	0.969	83.1%
White Swim Solid (nonlinear)	0°	s	0.157	0.310	0.538	0.762	0.996	1.470	1.947	
		μ	0.871	0.845	0.794	0.771	0.766	0.765	0.765	13.9%
	45°	s	0.160	0.330	0.600	0.870	1.133	1.637	2.145	
		μ	0.887	0.899	0.885	0.880	0.872	0.852	0.843	6.6%
	90°	s	0.193	0.382	0.693	0.985	1.293	1.870	2.460	
		μ	1.070	1.041	1.022	0.996	0.995	0.973	0.967	10.7%
Black Denim (nonlinear)	45°	s	0.260	0.457	0.750	1.033	1.291	1.766	2.227	
		μ	1.442	1.246	1.106	1.045	0.993	0.919	0.876	64.6%
Navy Sparkle Sweat (nonlinear)	45°	s	0.443	0.812	1.346	1.796	2.194	-	-	
		μ	2.456	2.213	1.986	1.816	1.688	-	-	45.5%
Tango Red Jet Set (nonlinear)	0°	s	0.228	0.434	0.728	1.019	1.306	1.903	2.496	
		μ	1.264	1.183	1.074	1.031	1.005	0.990	0.981	28.8%
	45°	s	0.220	0.388	0.656	0.923	1.189	1.690	2.228	
		μ	1.220	1.057	0.968	0.933	0.915	0.879	0.876	39.3%
	90°	s	0.166	0.320	0.566	0.818	1.061	1.539	2.029	
		μ	0.920	0.872	0.835	0.827	0.816	0.801	0.798	15.3%

Table 10: *Nonlinearity test. The cart weight is 4.5g.*