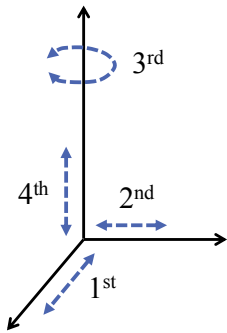


No.	DOF	Command	Frequency (Hz)	Phase (π rad)
1	N.A.	Take Off	9.6	1.4
2		Land	11.6	1.15
3	1 st	Forward	9.2	1.05
4	1 st	Back	8.0	0.0
5	2 nd	Left	10.4	0.1
6	2 nd	Right	8.8	0.7
7	3 rd	CW	8.4	0.35
8	3 rd	CCW	10.8	0.45
9	4 th	Up	10.0	1.75
10	4 th	Down	11.2	0.8
11	N.A.	Keep	12.0	1.8
12		Hover	12.4	1.45



DOF: degree of freedom; CW: clockwise; CCW: counterclockwise.

Extended Data Table 1 | Command encoding for the 4-DOF brain-controlled drone flight.

No. of subject	Decoding with CPU		Decoding with memristor	
	Accuracy (%)	ITR (bits/min)	Accuracy (%)	ITR (bits/min)
A1	88.75	134.42	88.75	134.42
A2	83.75	119.13	81.25	112.01
A3	85.42	124.06	85.42	124.06
A4	83.33	117.92	82.08	114.34
A5	89.17	135.77	88.33	133.08
Mean	86.08	126.26	85.17	123.58
Std	2.74	8.40	3.46	10.33

Extended Data Table 2 | Decoding results by the memristor chip and CPU for 5 different subjects.

Components	Area (μm^2)	Energy (pJ)
BL driver	13974.3	120.0
WL driver	345.2	16.5
Memristor array	1297.9	153.6
S&H	1.0	0.1
ADC	28200	840.0
Shift adder	5233.2	30.5
Subtractor	8858.3	66.0
Total	57909.9	1226.7

BL, bit line; WL, word line; S&H, sample & hold; ADC, analog-to-digital converter.

Extended Data Table 3. Benchmark of energy consumption and area for the memristor chip-based decoder.

a

No. of subject	Retained parameters				
	Top 20%	Top 40%	Top 60%	Top 80%	Top 100%
1	89.58	90.00	90.00	90.42	90.42
2	79.17	81.67	83.75	83.33	83.33
3	78.75	78.33	77.50	77.50	77.08
4	75.00	80.33	80.42	80.83	80.83
5	87.50	86.67	85.83	85.42	85.41
Mean	82.00	83.40	83.50	83.50	83.41

b

No. of subject	Pruned parameters						
	None	Top 1%	Top 2%	Top 5%	Top 10%	Top 15%	Top 20%
1	90.42	90.00	90.00	90.42	74.17	49.58	30.83
2	83.33	82.92	77.50	69.17	57.92	46.25	41.25
3	77.08	72.92	65.83	49.17	33.75	24.17	19.58
4	80.83	77.08	76.67	71.25	44.17	28.33	17.92
5	85.41	87.50	85.42	83.75	83.33	72.08	55.83
Mean	83.41	82.08	79.08	72.75	58.67	44.08	33.08

14

15 **Extended Data Table 4. Pruning experiments with masks on the decoder parameters.**

16 **a**, Results for 5 different experiments where masks are applied to retain parameters with
17 the top 20%, 40%, 60%, 80% and 100% of magnitudes, and prune the others. **b**, Results
18 for 7 different masks that are applied to prune parameters with the top 1%, 2%, 5%, 10%,
19 15%, 20% and 40% of magnitudes, and retain the others.