

Supplemental Information

Microfluidics Droplet Trapping, Splitting and Merging with Feedback Controls and State Space Modelling

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Table 1 – Screen shot of state space full matrix

stsp.state

stsp.A

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
1 pump_ch1_k-0	0.8154	0.0966	-0.2055	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2 pump_ch1_k-1	0.5000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3 pump_ch1_k-2	0	0.1250	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4 pump_ch2_k-0	0	0	0	0.8154	0.0966	-0.2055	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5 pump_ch2_k-1	0	0	0	0.5000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6 pump_ch2_k-2	0	0	0	0	0.1250	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7 pump_ch3_k-0	0	0	0	0	0	0	0.8154	0.0966	-0.2055	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8 pump_ch3_k-1	0	0	0	0	0	0	0.5000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9 pump_ch3_k-2	0	0	0	0	0	0	0	0.1250	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10 charge_1	0.3288	0.1165	-4.6982	-0.1264	-0.0448	1.8061	-0.1960	-0.0695	2.8013	1	0	0	5.1140e-06	-0.0012	-1.1935e-06	-1.0474e-06	1.2529e-04	0.0022	-4.7338e-05	-0.0198	-7.3320e-05	-0.0306	
11 charge_2	-0.1289	-0.0457	1.8424	0.1378	0.0488	-1.9609	-0.0114	-0.0040	0.1629	0	1	0	-2.0064e-06	8.6532e-04	1.2623e-06	4.0109e-08	-4.9157e-05	-8.4573e-04	5.1546e-05	0.0215	-2.0764e-06	-0.0018	
12 charge_3	-0.1999	-0.0708	2.8558	-0.0114	-0.0040	0.1629	0.3074	0.0735	-2.9641	0	0	1	-3.1078e-06	3.8380e-04	-1.0304e-07	1.1075e-06	-7.6137e-05	-0.0013	-4.2076e-06	-0.0018	7.5288e-05	0.0324	
13 U_c1.fluid_a	3.2843	1.1641	-46.9299	-1.2885	-0.4567	18.4121	-1.9958	-0.7074	28.5178	0	0	0	-5.7278e-34	2.1954e-31	1.3644e-34	1.3540e-34	1.0981e-32	3.2552e-30	-8.5121e-34	9.4391e-32	-1.4091e-33	1.9650e-31	
14 U_c1.fluid_c	0.1121	0.0397	-1.6011	0.0064	0.0023	-0.0915	0.0100	0.0035	-0.1423	0	0	0	-1.7545e-35	6.3574e-33	3.9882e-36	3.9882e-36	4.2095e-35	9.5006e-32	-2.9129e-35	-1.2111e-33	-4.8952e-35	-1.1589e-33	
15 U_c2.fluid_a	-1.2885	-0.4567	18.4121	1.4031	0.4973	-20.0489	-0.1145	-0.0406	1.6365	0	0	0	2.3613e-34	-8.6369e-32	-5.4097e-35	-5.4034e-35	-1.2155e-33	-1.2890e-30	3.8603e-34	7.4570e-33	1.4606e-34	-2.2972e-34	
16 U_c1.fluid_a	-1.9958	-0.7074	28.5178	-0.1145	-0.0406	1.6365	2.1103	0.7480	-30.1543	0	0	0	4.0172e-34	-1.4006e-31	9.3613e-35	-9.2397e-35	-2.9637e-33	-1.2890e-30	3.8606e-34	-2.2972e-34	1.0815e-33	-2.2246e-32	
17 U_c1.fluid_a	3.2843	1.1641	-46.9299	-1.2885	-0.4567	18.4121	-1.9958	-0.7074	28.5178	0	0	0	4.4822e-34	-2.1499e-32	-2.8667e-35	-4.0772e-35	1.1179e-31	-6.2215e-31	1.9251e-33	1.6094e-30	1.4712e-33	2.7825e-30	
18 U_c1.fluid_c	0.1121	0.0397	-1.6011	0.0031	0.0011	-0.0447	0.0049	0.0017	-0.0693	0	0	0	-1.8789e-35	6.0544e-33	4.2942e-36	4.2096e-36	8.7887e-35	1.0232e-31	-3.0715e-35	6.9678e-34	-1.5124e-35	-1.9440e-34	
19 U_c1.fluid_a	-1.2885	-0.4567	18.4121	1.4031	0.4973	-20.0489	-0.1145	-0.0406	1.6365	0	0	0	-2.6078e-35	1.5489e-32	9.4538e-36	9.2396e-36	1.9991e-33	2.5784e-31	4.6341e-35	2.7373e-32	1.3115e-35	4.4733e-32	
20 U_c1.fluid_c	0.0168	0.0059	-0.2394	0.1102	0.0391	-1.3746	0.0015	5.2784e-04	-0.0213	0	0	0	-1.2482e-37	-1.9997e-35	-5.6855e-39	1.0217e-40	-5.2029e-35	-1.5946e-34	4.9654e-37	7.2318e-34	-1.3771e-36	-1.2843e-32	
21 U_c1.fluid_a	-1.9958	-0.7074	28.5178	-0.1145	-0.0406	1.6365	2.1103	0.7480	-30.1543	0	0	0	-5.9724e-35	2.9962e-32	1.5622e-35	1.5450e-35	3.6046e-33	3.7875e-31	-4.3115e-35	4.4232e-32	-8.5386e-35	8.0480e-32	
22 U_c1.fluid_c	0.0260	0.0092	-0.3708	0.0015	5.2784e-04	-0.0213	0.1010	0.0358	-1.4432	0	0	0	-2.5929e-37	-1.9135e-35	1.7515e-40	9.8940e-39	-8.9956e-35	-4.4490e-35	-1.3771e-36	-1.2843e-32	-5.0564e-36	-2.2265e-33	
23																							

stsp.B

stsp.B

	1	2	3	4	5
1 U_ch1.voltage_source	0	0	0	0	
2 U_ch2.voltage_source	0	0	0	0	
3 U_ch3.voltage_source	0	0	0	0	
4	0	0	0	0	
5	0	0	0	0	
6	0	0	0	0	
7	0	0	0	0	
8	0	0	0	0	
9	0	0	0	0	
10	0	0	0	0	
11	0	0	0	0	
12	0	0	0	0	
13	0	0	0	0	
14	0	0	0	0	
15	0	0	0	0	
16	0	0	0	0	
17	0	0	0	0	
18	0	0	0	0	
19	0	0	0	0	
20	0	0	0	0	
21	0	0	0	0	
22	0	0	0	0	
23	0	0	0	0	

stsp.input

stsp.input

	1
1 U_ch1.voltage_source	
2 U_ch2.voltage_source	
3 U_ch3.voltage_source	
4	
5	
6	
7	
8	
9	
10	
11	
12	
13	
14	
15	
16	
17	
18	
19	
20	
21	
22	
23	

stsp.output

stsp.C

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
1 charge_1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
2 charge_2	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
3 charge_3	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
4																							

stsp.D

stsp.D

	1	2	3	4	5	6	7	8
1	0	0	0	0				
2	0	0	0	0				
3	0	0	0	0				
4								

Section I

Section II

Section III

Table 2 – Enlarged images for each section

Section I

stsp.state	
stsp.state	
1	
1	pump_th1_k-0
2	pump_th1_k-1
3	pump_th1_k-2
4	pump_th2_k-0
5	pump_th2_k-1
6	pump_th2_k-2
7	pump_th3_k-0
8	pump_th3_k-1
9	pump_th3_k-2
10	charge_1
11	charge_2
12	charge_3
13	II_c1/fluid_a
14	Uc_c1/fluid_c
15	II_c2/fluid_a
16	II_c3/fluid_a
17	II_t1/fluid_a
18	Uc_t1/fluid_c
19	II_t2/fluid_a
20	Uc_t2/fluid_c
21	II_t3/fluid_a
22	Uc_t3/fluid_c
23	

stsp.output	
stsp.output	
1	
1	charge_1
2	charge_2
3	charge_3
4	

Section III

stsp.B					
stsp.B					
1	2	3	4	5	
1	4	0	0		
2	0	0	0		
3	0	0	0		
4	0	4	0		
5	0	0	0		
6	0	0	0		
7	0	0	4		
8	0	0	0		
9	0	0	0		
10	0	0	0		
11	0	0	0		
12	0	0	0		
13	0	0	0		
14	0	0	0		
15	0	0	0		
16	0	0	0		
17	0	0	0		
18	0	0	0		
19	0	0	0		
20	0	0	0		
21	0	0	0		
22	0	0	0		
23					

stsp.D							
stsp.D							
1	2	3	4	5	6	7	8
1	0	0	0				
2	0	0	0				
3	0	0	0				
4							

stsp.input	
stsp.input	
1	
1	U_ch1/voltage_source
2	U_ch2/voltage_source
3	U_ch3/voltage_source
4	
5	
6	
7	
8	
9	
10	
11	
12	
13	
14	
15	
16	
17	
18	
19	
20	
21	
22	
23	

Section II

stsp.A

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
1	0.8154	0.0986	-0.2055	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	0.5000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	0	0.1250	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0.8154	0.0986	-0.2055	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0.5000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0.1250	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0.8154	0.0986	-0.2055	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0.5000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0	0.1250	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10	0.3288	0.1165	-4.6982	-0.1264	-0.0448	1.8062	-0.1960	-0.0695	2.8013	1	0	0	5.1140e-06	-0.0012	-1.1593e-06	-1.0474e-06	1.2529e-04	0.0022	-4.7338e-05	-0.0198	-7.3320e-05	-0.0306	-0.0018
11	-0.1289	-0.0457	1.8424	0.1378	0.0488	-1.9690	-0.0114	-0.0040	0.1629	0	1	0	-2.0064e-06	8.6532e-04	1.2623e-06	-6.0109e-08	-4.9157e-05	-8.4573e-04	5.1546e-05	0.0215	-4.2076e-06	-0.0018	-0.0018
12	-0.1999	-0.0708	2.8558	-0.0114	-0.0040	0.1628	0.2074	0.0735	-2.9641	0	0	1	-3.1076e-06	3.8380e-04	-1.0304e-07	1.1075e-06	-7.6137e-05	-0.0013	-4.2076e-06	-0.0018	7.7538e-05	0.0324	0.0324
13	3.2843	1.1641	-46.9299	-1.2885	-0.4567	18.4121	-1.9958	-0.7074	28.5178	0	0	0	-5.7278e-34	2.1954e-31	1.3644e-34	1.3540e-34	1.0981e-32	3.2552e-30	-8.5121e-34	9.4591e-32	-1.4091e-33	1.9650e-31	1.9650e-31
14	0.1121	0.0397	-1.6011	0.0064	0.0023	-0.0919	0.0100	0.0035	-0.1423	0	0	0	-1.7545e-35	6.3574e-33	3.9882e-36	3.9882e-36	4.2095e-35	9.5006e-32	-2.9129e-35	-1.2111e-33	-4.8952e-35	-1.1589e-33	-1.1589e-33
15	-1.2885	-0.4567	18.4121	1.4031	0.4973	-20.0486	-0.1145	-0.0406	1.6365	0	0	0	2.3613e-34	-8.6369e-32	-5.4097e-35	-5.4024e-35	-1.2155e-33	-1.2890e-30	3.8603e-34	7.4570e-33	6.4606e-34	-2.2972e-34	-2.2972e-34
16	-1.9958	-0.7074	28.5178	-0.1145	-0.0406	1.6365	2.1103	0.7480	-30.1543	0	0	0	4.0172e-34	-1.4806e-31	-9.2613e-35	-9.2397e-35	-2.9637e-33	-2.2073e-30	6.4606e-34	-2.2972e-34	1.0815e-33	-2.2246e-32	-2.2246e-32
17	3.2843	1.1641	-46.9299	-1.2885	-0.4567	18.4121	-1.9958	-0.7074	28.5178	0	0	0	4.4822e-34	-2.1499e-32	-2.8667e-35	-4.0772e-35	1.1179e-31	1.9251e-33	1.6094e-30	3.4712e-33	2.7825e-30		
18	0.1205	0.0427	-1.7213	0.0031	0.0011	-0.0447	0.0049	0.0017	-0.0693	0	0	0	-1.8769e-35	6.8544e-33	4.2942e-36	4.2896e-36	8.7887e-35	1.0232e-31	-3.0715e-35	-6.9678e-34	-5.1524e-35	-1.9440e-34	-1.9440e-34
19	-1.2885	-0.4567	18.4121	1.4031	0.4973	-20.0486	-0.1145	-0.0406	1.6365	0	0	0	-3.6078e-35	1.5449e-32	9.4538e-36	9.2294e-36	1.9991e-33	2.2578e-31	-4.6241e-35	2.2373e-32	-6.3115e-35	4.4232e-32	4.4232e-32
20	0.0168	0.0059	-0.2394	0.1102	0.0391	-1.5746	0.0015	5.2784e-04	-0.0213	0	0	0	-1.2482e-37	-1.9997e-35	-5.6855e-39	1.0217e-40	-5.2029e-35	-1.5946e-34	-6.9654e-37	-7.2318e-34	-1.3771e-36	-1.2843e-33	-1.2843e-33
21	-1.9958	-0.7074	28.5178	-0.1145	-0.0406	1.6365	2.1103	0.7480	-30.1543	0	0	0	-5.9724e-35	2.5962e-32	1.5822e-35	1.5450e-35	3.6046e-33	3.7875e-31	-6.3115e-35	4.4232e-32	-9.8536e-35	8.0480e-32	8.0480e-32
22	0.0260	0.0092	-0.3708	0.0015	5.2784e-04	-0.0213	0.1010	0.0358	-1.4432	0	0	0	-2.5929e-37	-1.9135e-35	1.7515e-40	9.8940e-39	-8.9956e-35	-4.4490e-35	-1.3771e-36	-1.2843e-33	-2.5056e-36	-2.2265e-33	-2.2265e-33
23																							

stsp.C

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
4																							