Supplementary material: A jump persistent turning walker to model zebrafish locomotion

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1. Comparison of fish speed and turn rate

Figure S1 illustrates that higher turn rates are more likely at lower speeds. Significant reductions in the fish speed are exemplified in Fig. S2 through short plateaus in the path length. Ultimately, they are responsible for moderate variations of the fish speed: Fish 1, 5.68 $\pm$ 2.01 cm s^{-1}; Fish 2, 2.79 $\pm$ 0.94 cm s^{-1}; Fish 3, 6.52 $\pm$ 1.61 cm s^{-1}; Fish 4, 5.19 $\pm$ 1.57 cm s^{-1}; Fish 5, 4.96 $\pm$ 2.24 cm s^{-1}; Fish 6, 5.62 $\pm$ 1.62 cm s^{-1}; Fish 7, 6.71 $\pm$ 1.70 cm s^{-1}; Fish 8, 7.51 $\pm$ 2.13 cm s^{-1}. Following [35], here we focus on the turn rate; future work will address variations in the fish speed and possible couplings between turn rate and speed.

2. Split tests

Split tests (Table S1) were performed to ensure consistency of parameters within two halves of an experiment. Parameters of the JPTW model were estimated using the 5 min video and compared to the parameters estimated using only the first half (2.5 min) and the second half (2.5 min) of the same data. One-way ANOVA tests show that the JPTW model parameters are not significantly different between any two halves for all trials ($p = 0.7555$, $F_{1,12} = 0.28$ for θ; $p = 0.855$, $F_{1,12} = 0.16$ for σ; $p = 0.6657$, $F_{1,12} = 0.41$ for γ; and $p = 0.8206$, $F_{1,12} = 0.2$ for λ).

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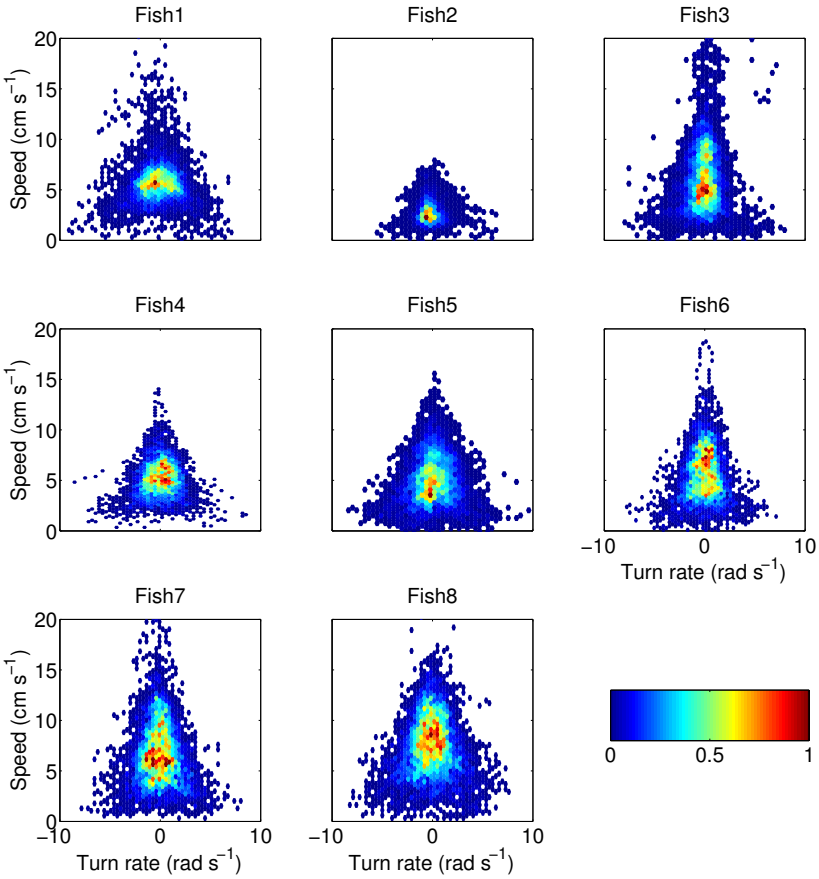

Figure S1. Density plot of fish turn rate and speed. Correlation analysis between fish speed and turn rate shows that both the quantities have negligible correlation (less than 0.05 in absolute value). The triangular shape of the density plot of zebrafish turn rate against speed indicates that high turn rate occurs mainly at lower speed. Note that the colorbar is normalized from zero to one. Color coding in each panel refers to the likelihood of any combination of turn rate and speed, with one identifying the most common occurrence in the graph.

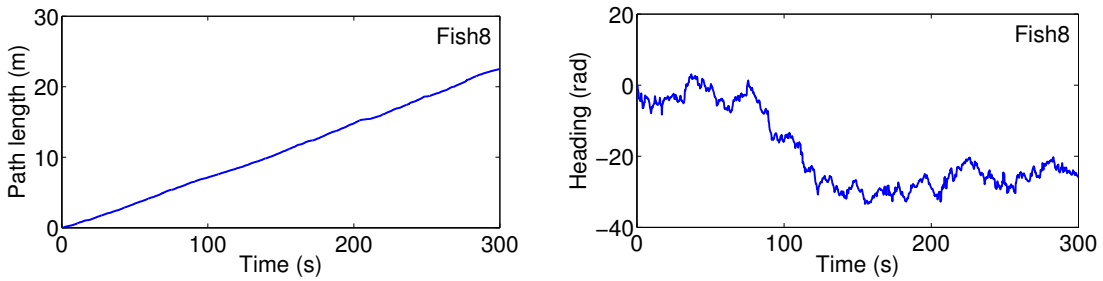

Figure S2. A sample zebrafish time series data plotted in intrinsic coordinates. The slope of the path length as a function of time in (a) is constant, and the time series of the fish direction of motion in (b) is highly variable.

Table S1. *Split test for jump persistent turning walker(JPTW) model.*

Data	$\theta(s^{-1})$	$\sigma(\text{rad } s^{-1})$	$\gamma(\text{rad } s^{-1})$	$\lambda(s^{-1})$
Fish 1	1.470	3.001	3.064	0.011
1^{st} half	1.523	3.143	3.159	0.009
2^{nd} half	1.425	2.844	2.978	0.014
Fish 2	1.013	1.145	1.565	0.015
1^{st} half	1.104	1.148	1.698	0.013
2^{nd} half	0.908	1.140	1.442	0.017
Fish 3	1.307	1.976	2.323	0.023
1^{st} half	1.579	2.707	2.847	0.021
2^{nd} half	1.164	1.479	1.570	0.011
Fish 4	1.460	2.491	2.725	0.012
1^{st} half	1.522	2.814	3.026	0.013
2^{nd} half	1.369	2.178	1.980	0.009
Fish 5	1.779	3.390	3.451	0.012
1^{st} half	1.760	3.344	3.390	0.011
2^{nd} half	1.798	3.436	3.500	0.013
Fish 6	1.299	2.197	2.422	0.016
1^{st} half	1.325	2.238	2.517	0.017
2^{nd} half	1.259	2.150	2.335	0.015
Fish 7	1.594	2.665	2.777	0.012
1^{st} half	1.599	2.520	2.650	0.012
2^{nd} half	1.610	2.826	2.889	0.012
Fish 8	1.688	3.415	3.206	0.012
1^{st} half	1.635	3.366	3.051	0.011
2^{nd} half	1.751	3.468	3.332	0.012

Parameters estimated using the 5 min video are compared to the parameters estimated using only the first half and the second half of the data. Comparison shows that the parameter values are not significantly different across the two halves.