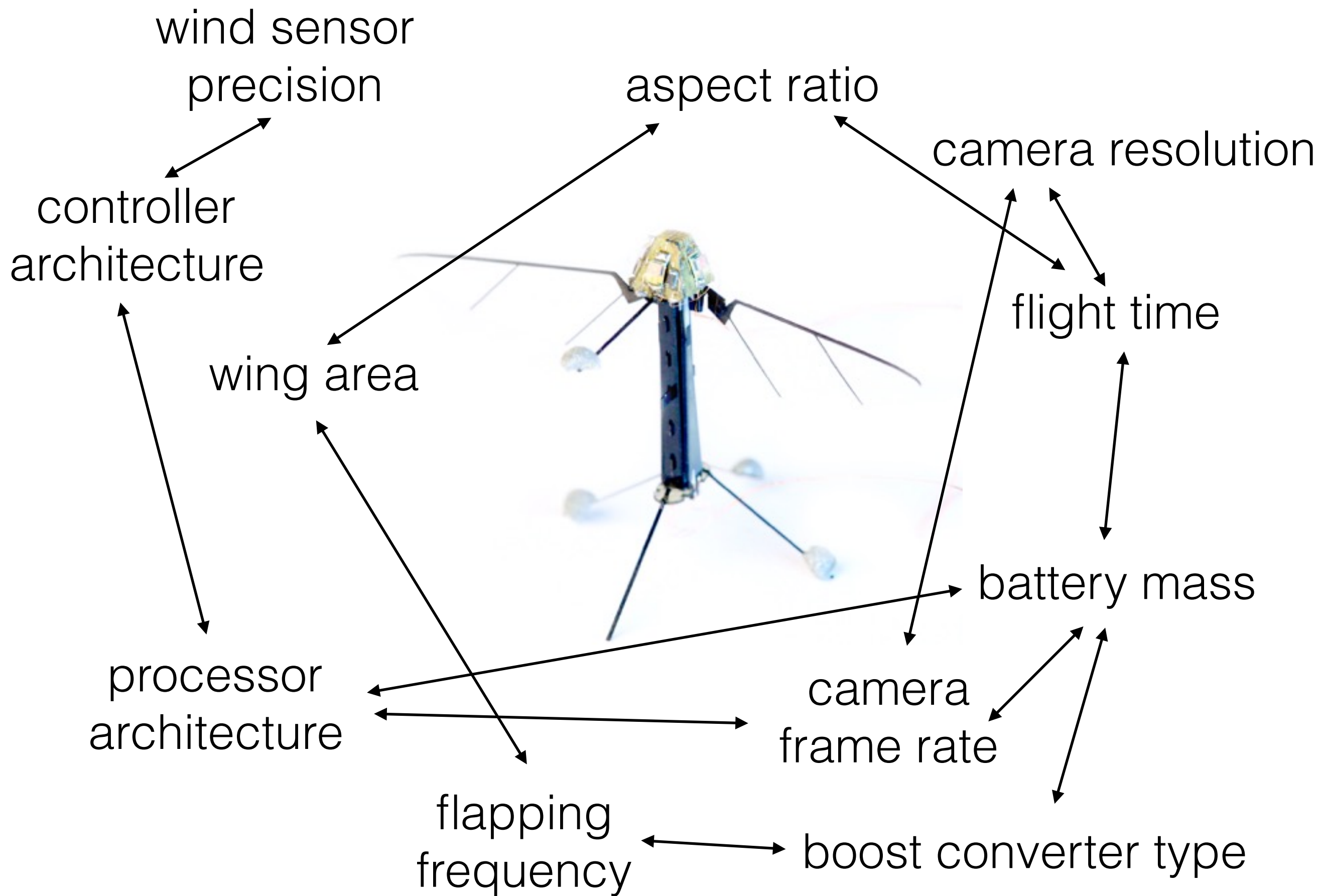


don't model things.
just build robots

Dr. Sawyer B. Fuller
Assistant Professor
Department of Mechanical Engineering



UNIVERSITY *of* WASHINGTON



#1 aircraft design technique

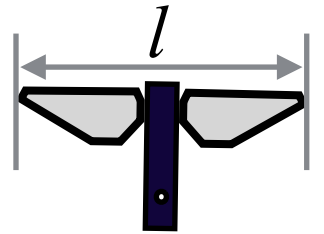
iterating on previous successful designs

design for evolvability

fast iteration like nature does



small is different



scaling laws:

mechanics

characteristic	strength per mass	remarks
viscous friction	l^{-1}	unfavorable glide ratio: favors hover
coulomb friction	l^{-1}	inefficient pin joints: favors flexures

unfavorable to gliding flight, propellers

sensing

characteristic	varies with	remarks
Glob. Pos. System error	l^{-1}	denied indoors
battery power	l^3	suggests non-emissive sensing

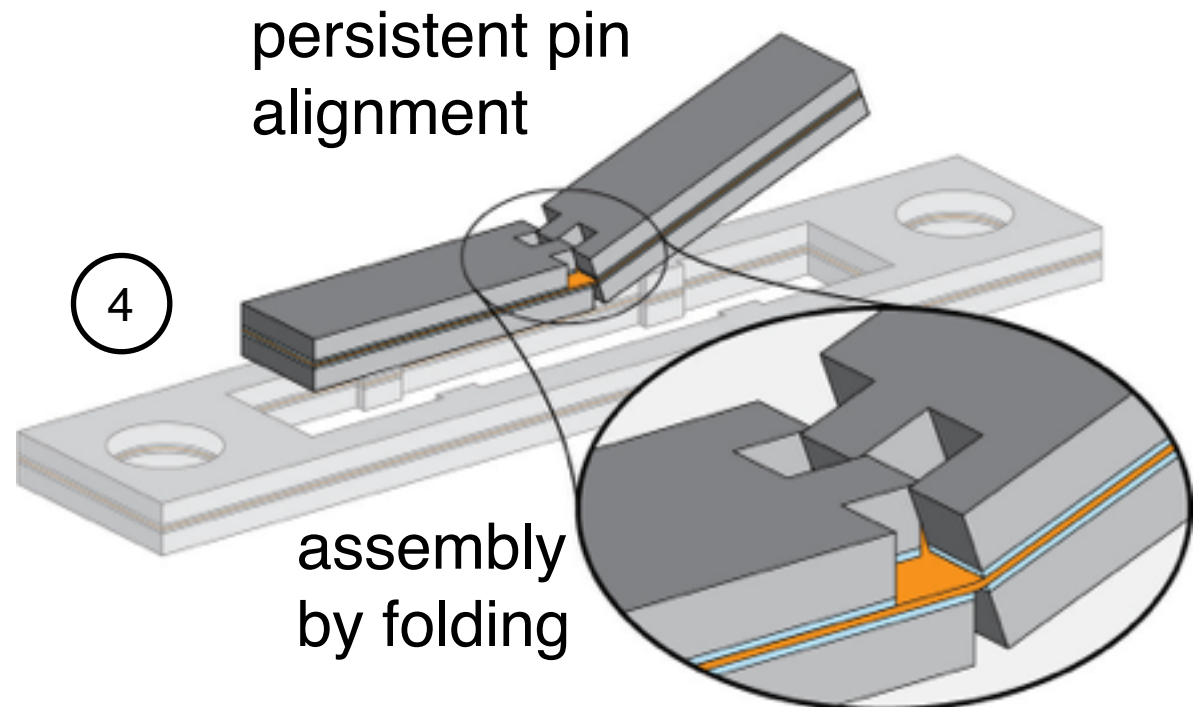
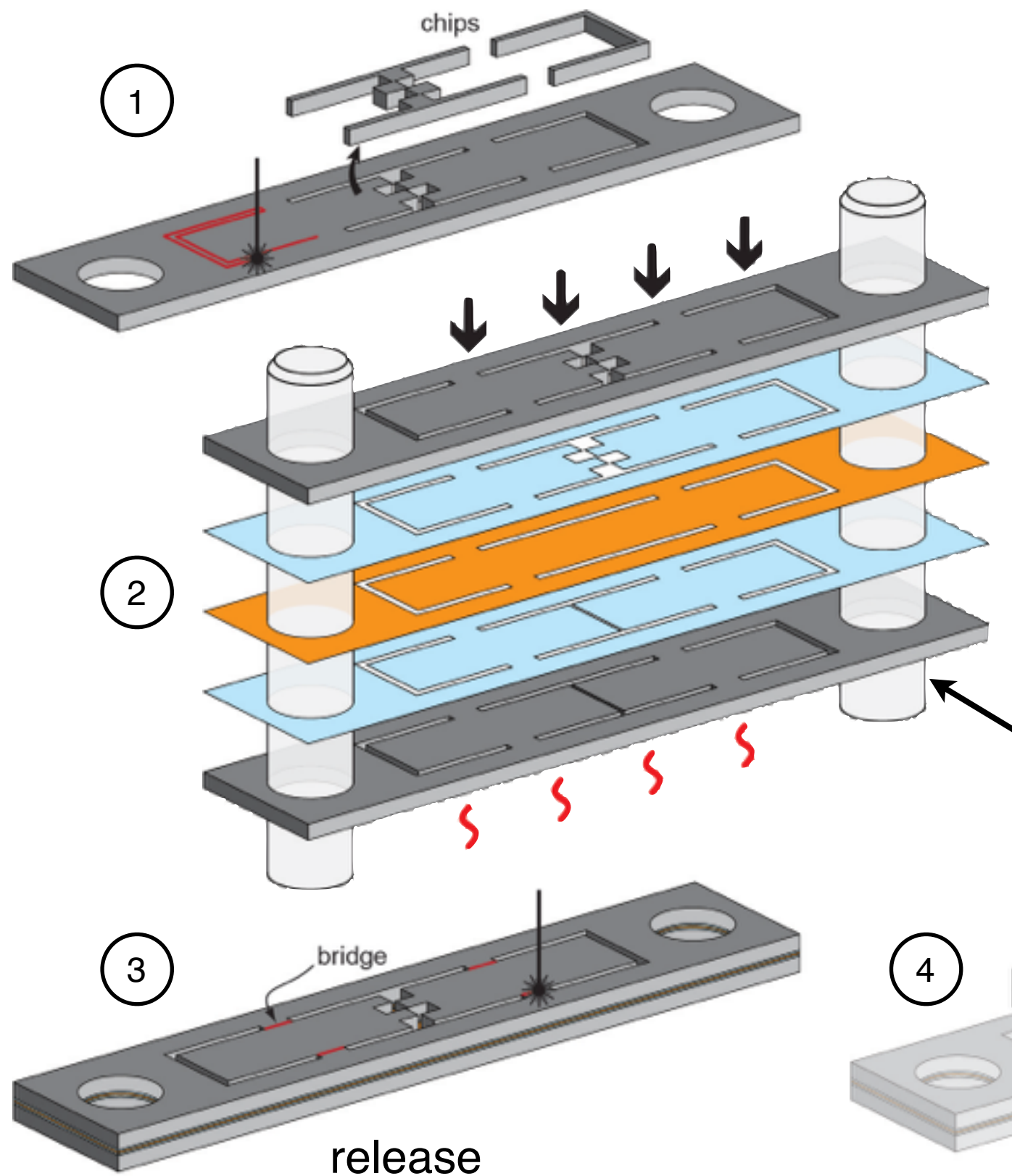
eliminates many sensors

control

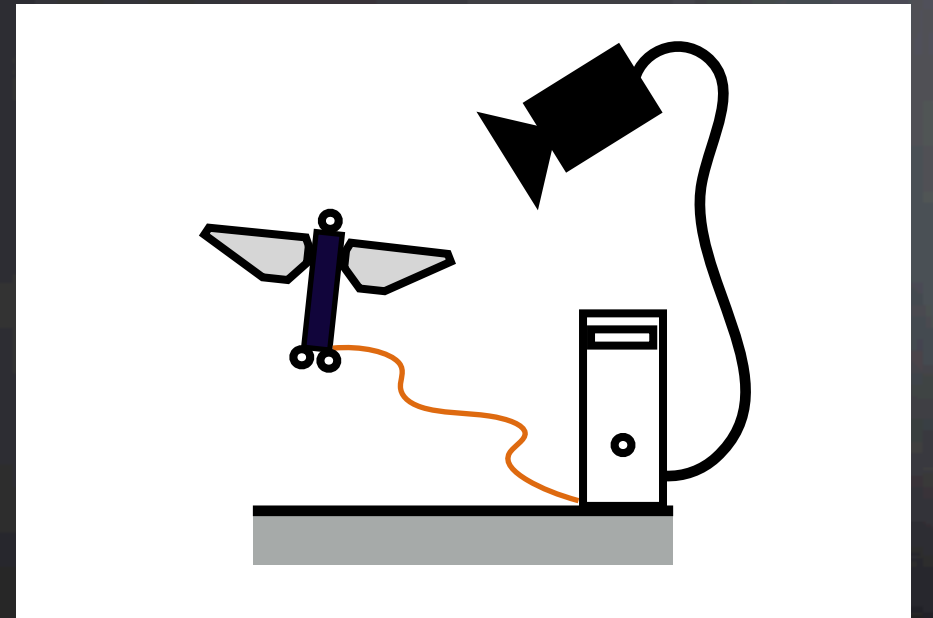
characteristic	varies with	remarks
rotation speed	l^{-1}	requires fast feedback loop
computation power	l^3	constrained processing

faster dynamics × slower computation

manufacturing at insect scale



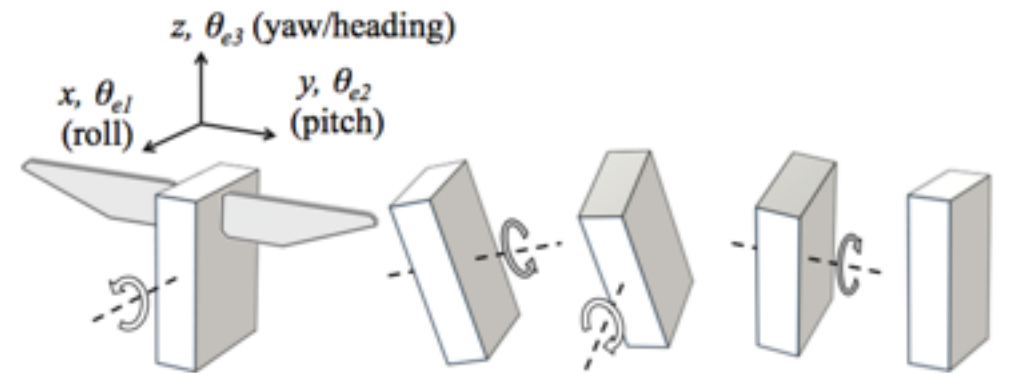
controlled flight (real time)



Ma K, Chirarattananon P, **Fuller SB**, and Wood RJ, *Science* 2013

fast rotational motions

torque $\sim l^4$, moment of inertia $\sim l^5$
→ angular acceleration $\sim l^{-1}$

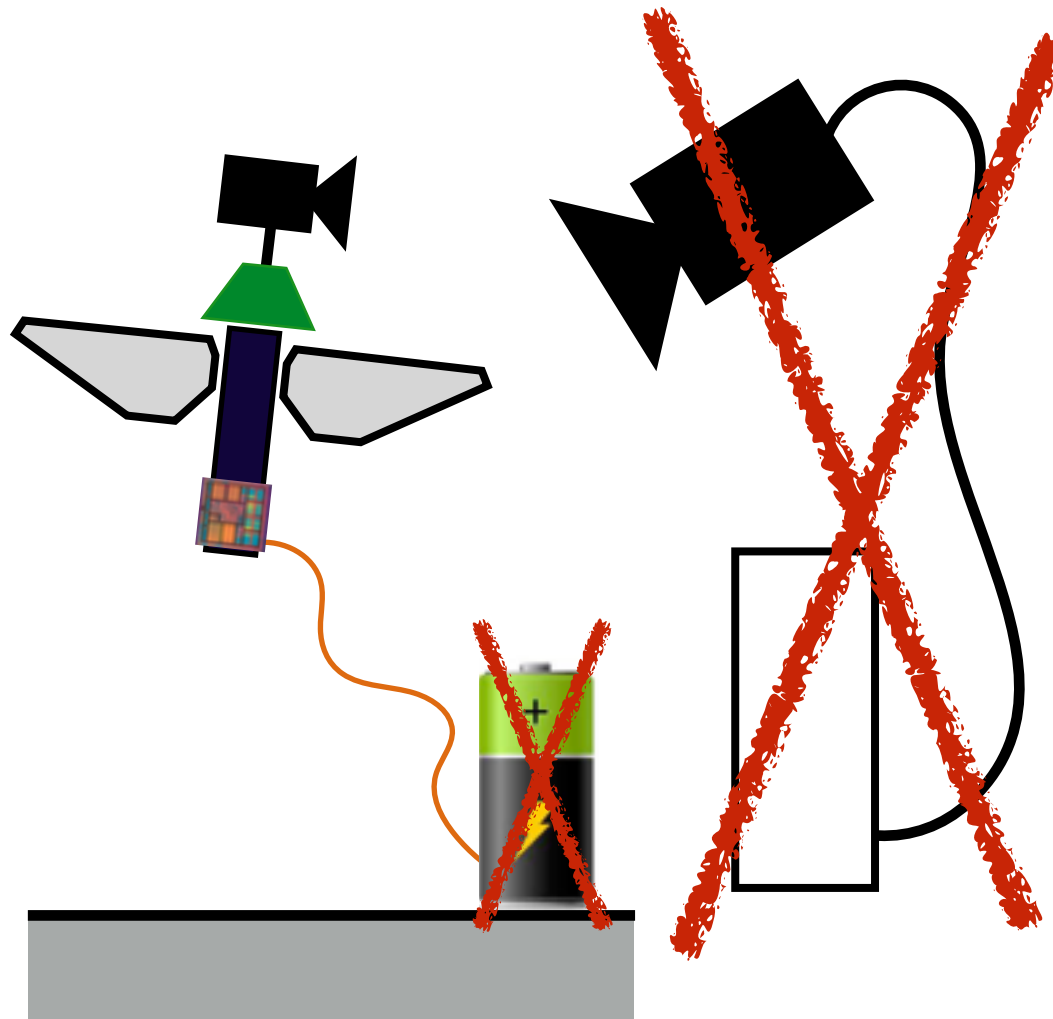


Perching



Graule M, Chirarattananon P,
Fuller SB, et al. *Science* 2016

open challenges



visual flight control,
computation autonomy,
and power autonomy