Gliders, bicycles and walking robots

Abstract:

Many airplanes can, or nearly can, glide stably without control. So it seems natural that the first successful powered flight followed from mastery of gliding. Many bicycles can, or nearly can, balance themselves when in motion. Bicycle design seems to have evolved to gain this feature. We can make robots that, like a stable glider or coasting bicycle, stably walk without motors or control in a remarkably human-like way. So it makes sense to use `passive-dynamics’ as a core for developing the control of walking robots and to gain understanding of the control of walking people. That’s what I used to think.

But, so far, this has not led to robust walking robots. What about human evolution? We didn’t evolve dynamic bodies and then learn to control them. Rather, people had elaborate control systems way back when we were fish and even worms. But if control is paramount, why is it that uncontrolled passive-dynamic walkers can walk so much like humans? It seems that energy-optimal control, perhaps a proxy for evolutionary development, arrives at solutions that have features in common with passive-dynamics. Rather than thinking of good powered walking as passive walking with a small amount of control added, I now think of powered walking as highly controlled, but with much of the motor action titrated out.

Biography:

Andy Ruina is a Professor of Mechanical Engineering at Cornell University where he has been, but for various leaves, since the afternoon of Monday August 25, 1980. He teaches various basic mechanics and math classes. His early research was on rock friction and sliding instability, with the aim of increasing understanding of earthquakes, and now his biomechanics and robotics lab focusses on legged locomotion. He has also worked on bicycles, solid mechanics and fracture. He likes classical rigid-object dynamics, especially contact (collisions, friction, non-holonomic constraints). He likes simple and ideal models. His degrees are from Engineering at Brown (ScB. 76, ScM. 78, Ph.D. 81).

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