

Human-in-the-Loop Cost-Aware Bayesian Optimization for Hardware-Software Devices

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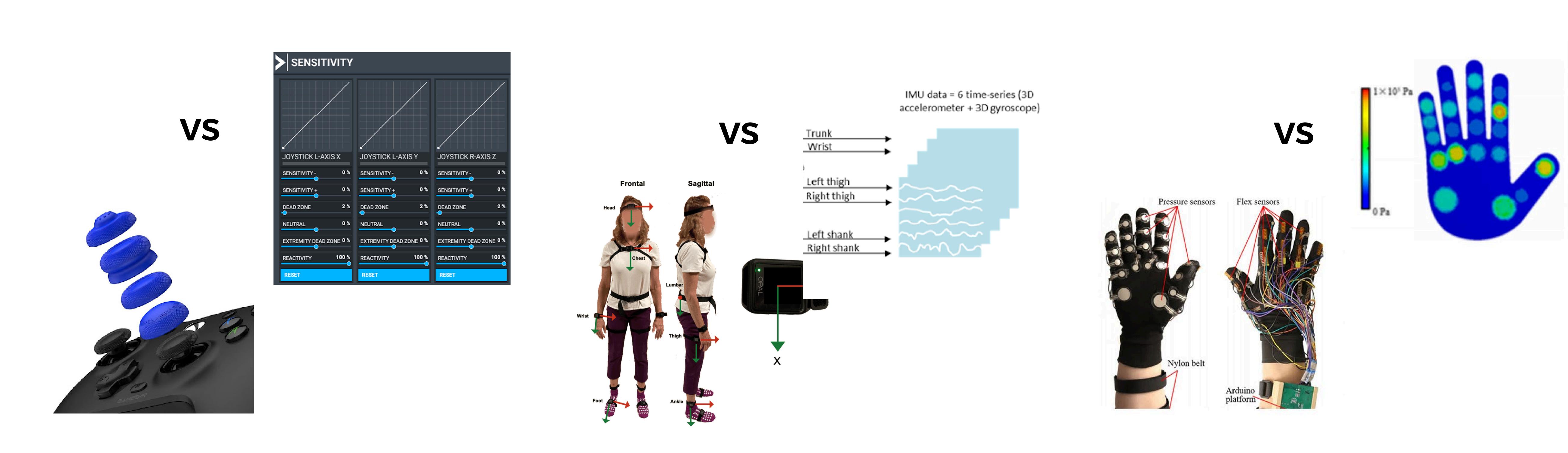
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making hardware is hard

Prototyping interactive devices means exploring huge design spaces with both hardware and software changes.

- Hardware changes can take hours or days (such as for fabrication, assembly or testing)
- Software changes are faster, but still need integration or user testing
- · In personalized systems, every user may need their own configuration, all under tight time and resource limits

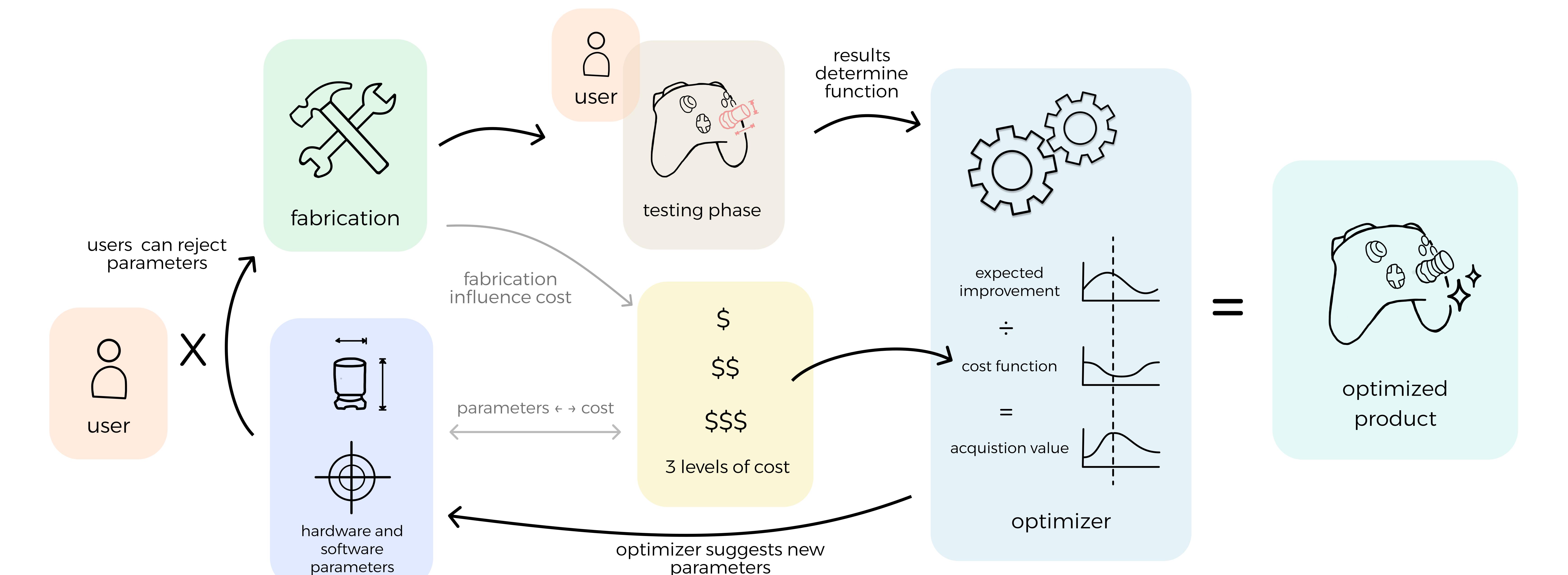
Human-in-the-loop bayesian optimization can guide the search by modeling performance and using user feedback - but most methods treat all changes as equally costly.



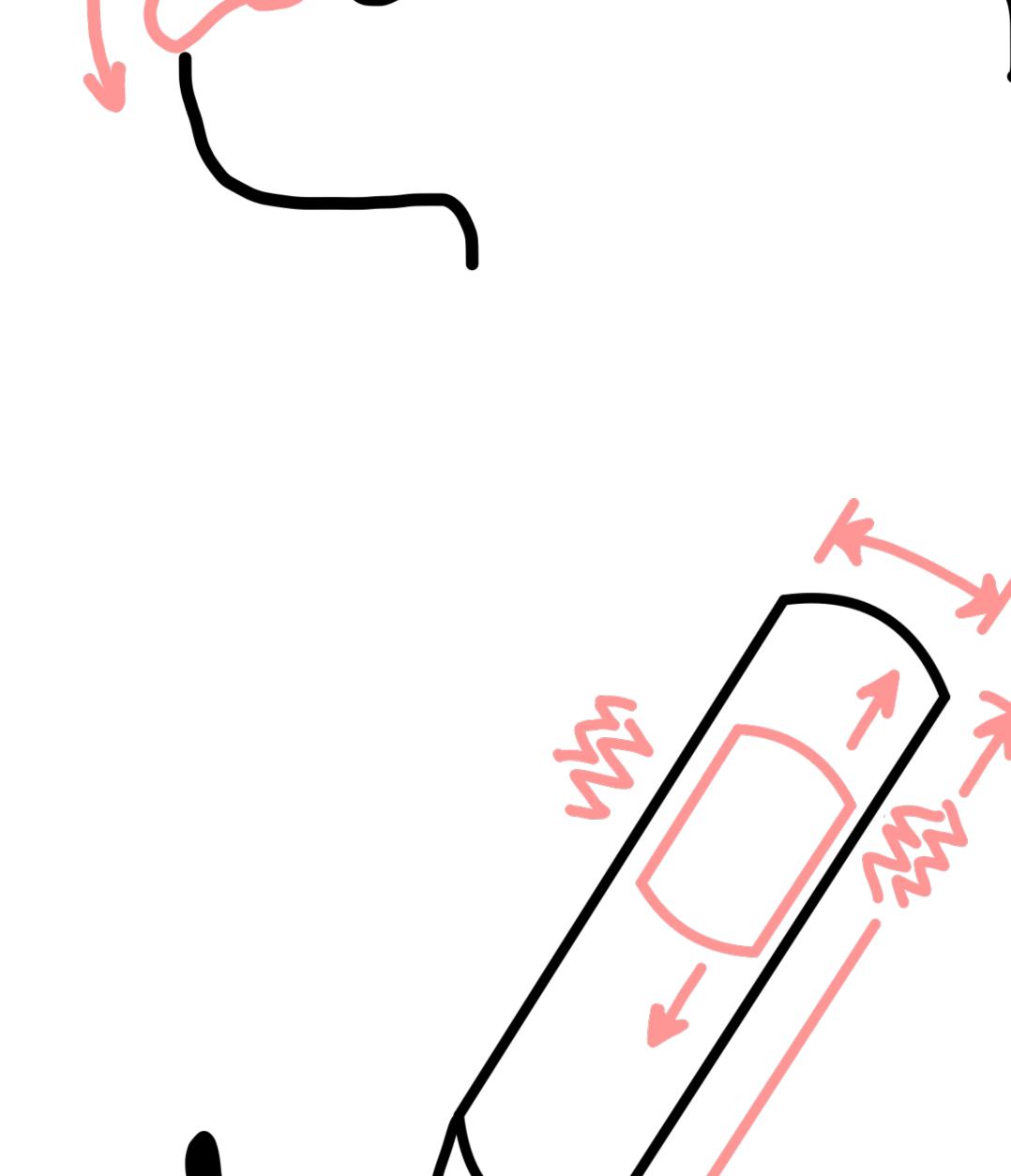
so the question is ...

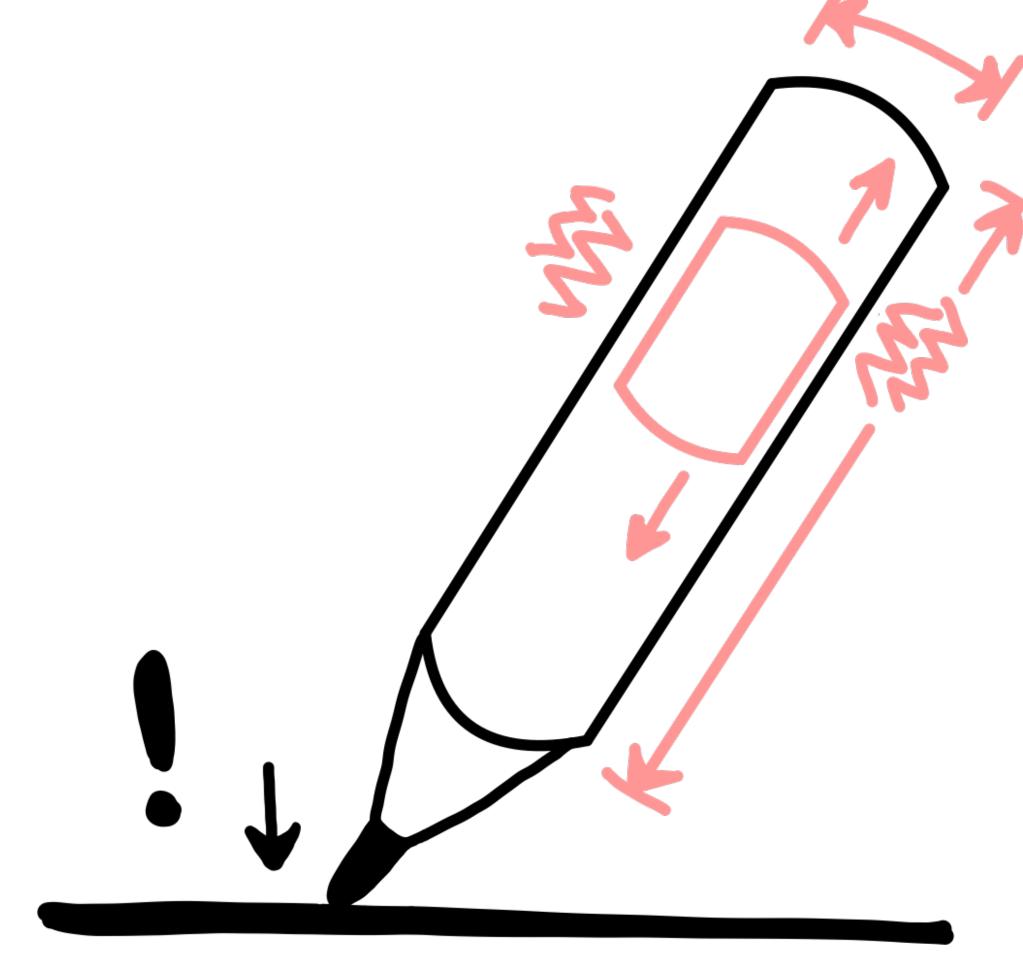
... how can we prototype hardware and software parameters together, while also considering for the costs of each design change?

the solution? cost-aware bayesian optimization



applications





We model the cost of making and testing prototypes by tracking the current setup and past fabricated parts in order to

- suggest cheap changes first,
- reuse existing hardware when possible,
- only propose expensive builds if the predicted benefit is worth it.

This cost model we include directly as a cost function in the optimization process and combine it with the expected improvement (user performance and preference) which results in an acquisition value - the higher the more likely it will suggest this new design. The new design consists of software and hardware parameters which the user can reject, letting human judgment guide the process. The new design will be fabricated, tested by the user and its performance and preference will be feed into the system - and the loops starts again.



We also showed it works in three domains: a VR pointing device, a haptic pen, a 3Dprinted gaming joystick.

