Designing Human-Powered Interaction

Development and Evaluation of a Self-Powered Television Remote

Everyday products such as television remotes are used constantly but still depend on disposable batteries, despite very low energy demands. The hospitality sector shows the problem most clearly. Batteries fail unpredictably across hundreds of guest rooms, requiring reactive maintenance and generating guest complaints. Existing self-powered remotes rely on solar panels, which depend on the room being lit rather than on the product being used.

Human powered products convert mechanical energy from the user into electrical energy. Kinergizer demonstrated the technical feasibility of a scroll wheel harvester in a computer mouse prototype, but how this translates to a handheld remote, operated by the thumb without a supporting surface, had not been established.

Research question

How can a thumb-operated scroll interaction be designed to generate sufficient energy while remaining ergonomic and intuitive for first-time users?

Approach

The project followed a Research through Design approach, structured around the double diamond model. Ergonomic tests, energy generation measurements and interaction pattern analysis informed a series of design iterations, concluding in two integral prototypes and a structured user evaluation.

Energy performance

Signalling uses infrared for the power button, allowing the television to be woken from deep sleep, and Bluetooth Low Energy for all other commands. An interrupt-driven firmware architecture removes the continuous keypad polling found in conventional remotes. A rechargeable coin cell covers periods of non-use.

Generated per scroll	*3 mJ*
Generated, one-hour session	*438 mJ*
Consumed, same session	*66.66 mJ*
Surplus	*371 mJ*



User evaluation

A structured usability test was conducted with five participants using integral prototype v1. The mean System Usability Scale score was 76.5, above the 68 threshold considered average, with the scroll wheel itself rated highly by almost all participants. The issues identified, principally the clarity of the select function and the left and right navigation mapping, were addressed in the second prototype.

Conclusion

A thumb-operated scroll wheel can generate sufficient energy to power a television remote under normal use, provided that generation is treated as multifunctional rather than tied to a single input. The resulting concept requires no instruction, no additional behavior in how a remote is normally used, and no disposable batteries.

Design outcome

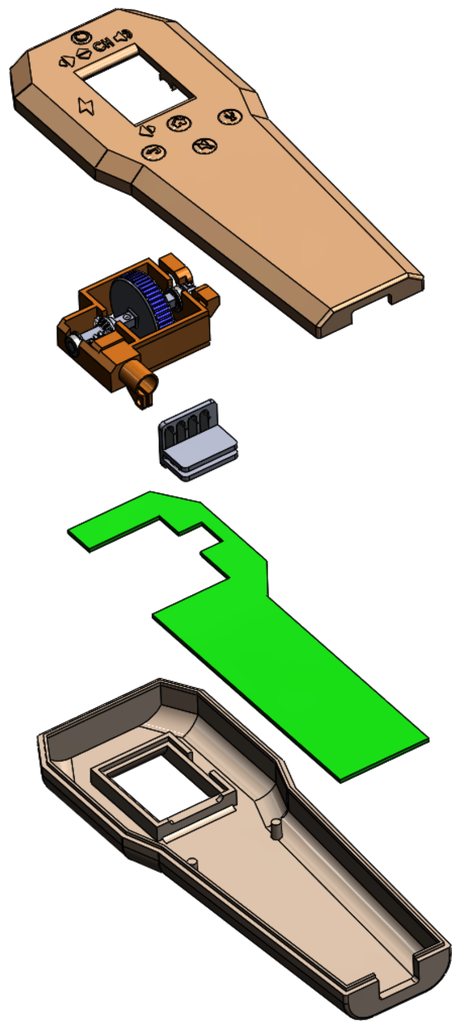
Energy is harvested intrinsically. Scrolling the wheel to change volume or navigate a menu drives a harvester inside the housing, and that same motion supplies the energy to send the command. No separate charging action is required and nothing changes about how a remote is normally used.

A single wheel slides along its axle to switch between four functions: volume, channel, up/down navigation and left/right navigation. Pressing the wheel registers a select command. Wheel position is detected by four reed switches responding to magnets embedded in the wheel, which requires no current, and a mechanical rotary encoder reads scroll direction and speed.

Multifunctional harvesting

Energy from a thumb-driven harvester is scarce, approximately 3mJ per scroll after system losses. Generation therefore has to be maximised wherever it is possible, rather than attached to a single function while the remainder of the remote only consumes. All four scrolling functions are routed through the harvester.

A single wheel achieves this while keeping the thumb in one position throughout use, which the ergonomic tests identified as the main determinant of comfort. It also requires only one harvester and keeps the surface of the remote visually simple.





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Integrated Product Design

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