An information engine with high performance and efficiency

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Information engines, a modern realization of the Maxwell-demon thought experiment, use feedback to extract work from a single heat bath. A 1929 variant proposal by Leo Szilard can extract energy from a heat bath and then store it as work, at an efficiency that can seemingly approach 100%. Previous experimental information engines have either demonstrated efficient energy conversion but no storage or storage but low efficiency. In our version, a heavy colloidal particle diffuses in water in a horizontal optical trap. Favorable "up" fluctuations are captured by ratcheting up the trap center, thereby converting bath fluctuations into stored gravitational potential energy. We discuss how to optimize performance in response to challenges (measurement noise) and opportunities (extra fluctuations in a nonequilibrium bath). Then we present experimental results for a new engine design that separates the acquisition of information from its storage. This separation of the protocol into two distinct stages allows for efficient work conversion and energy storage.