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Electromagnetic liquid pistons for capillarity-based pumping BERNARD MALOUIN, JOSEPH OLLES, LILI CHENG, AMIR HIRSA, Rensselaer Polytechnic Institute, MICHAEL VOGEL, Independent Researcher, Voorhees, NJ 08043 — Two adjoining ferrofluid droplets can behave as an electronically-controlled oscillator or switch by an appropriate balance of magnetic, capillary, and inertial forces. Their motion can be exploited to displace a surrounding liquid, forming electromagnetic liquid pistons. Such ferrofluid pistons can pump a precise volume of liquid via finely tunable amplitudes or resonant frequencies with no solid moving parts. Here we demonstrate the use of these liquid pistons in capillarity-dominated systems for variable focal distance liquid lenses with nearly perfect spherical interfaces. These liquid/liquid lenses feature many promising qualities not previously realized together in a liquid lens, including large apertures, immunity to evaporation, invariance to orientation relative to gravity, and low driving voltages. The dynamics of these liquid pistons is examined, with experimental measurements showing good agreement with a spherical cap model. A centimeter-scale lens was shown to respond in excess of 30 Hz, with resonant frequencies over 1 kHz predicted for scaled down systems.

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