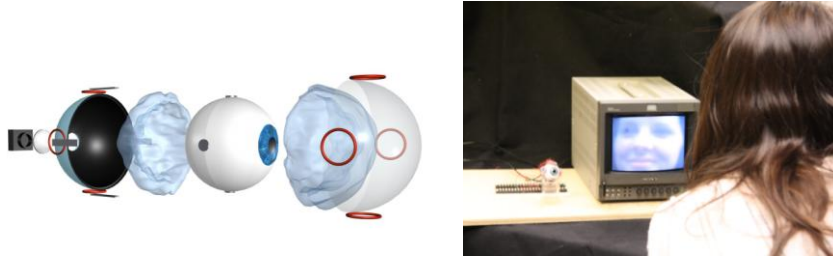


A Fluid-Suspension, Electromagnetically Driven Eye with Video Capability for Animatronic Applications

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(Our work of the same title was initially published at “Humanoid ’09” in Paris France, and should be referred to for details).

We have prototyped a compact, fluid-suspension, electromagnetically-rotated animatronic eye. The Eye has no external moving parts, features low operating power, a range of motion and saccade speeds that can exceed that of the human eye, and an absence of frictional wear points. It supports a rear, stationary, video camera. In a special application, the eye can be separated into a hermetically sealable portion that might be used as a human eye prosthesis along with an extra-cranially-mounted magnetic drive.

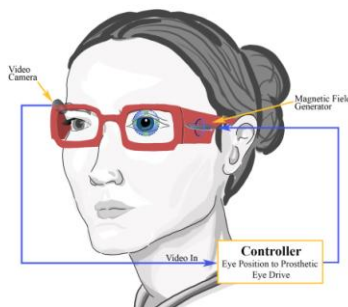


Our electromagnetic Eye design is a result of an iterative approach. We wanted a robotic eye installable in current animatronic (human-like robotic) figures that would address a number of issues. It needed to be small and self-contained (current animatronic eyes are driven by rods, gears and motors that fill much of the top of the head), realistic looking, low wear, and with fast movement capability. In addition we wanted to support computer vision.

Two of our earlier approaches (a free floating Eye with a hidden bar magnet swiveled by an external magnetic field, and a magnetically actuated “ball in socket” design) were essentially combined in a final system which is based on a sphere-within-a-sphere concept. The inner sphere is clear plastic, and is surrounded by, and neutrally buoyant in, a clear index-matching fluid. A clear plastic outer sphere is also index-matched to the fluid. The inner eye is painted to look like a human eye, but we leave the pupil area open to admit light (much as in a real human eye). A portion of the back of the inner eye is also left unpainted so that incoming light can reach a rear-mounted CCD imager (analogous to the retina of a human eye). With this scheme, the entire Eye acts as a single spherical lens (and it is the ONLY lens used in the system). The inner eye has small permanent magnets mounted at its north and south, and east and west, equatorial poles. These are used to slew the eye around with symmetrical, low-profile, external electromagnetic coils.

With this design, the magnification and gaze direction of the overall camera/eye is fixed. Due to the spherical symmetry of the overall system, even when the inner eye rotates, the Eye’s view does not change. The pupil opening is actually behind the front surface of the combined spherical lens and only acts as an aperture stop. The inner eyeball floats without touching the shell, virtually eliminating friction and allowing low power operation and long wear life.

Because of the magnification of the inner eye by the curved outer shell and index matching fluid, the inner eye’s surface appears to be the outer surface of the overall Eye assembly, so the outer surface of the Eye can be in contact with animatronic skin and still appear to rotate even though it actually does not.



Medical Application

In a special application, we believe it would be possible to separate our (hermetically sealed) Eye sphere from its magnetic drive. The sphere could serve as a prosthesis for a person who has lost an eye. The magnetic drive could be supplied extra-cranially (as shown in the figure) with a drive signal derived from the person’s remaining eye to synchronize the movement of the prosthesis.