# THE LIQUID LENS TECHNOLOGY
HOW IT WORKS AND WHAT IT IS DOING

Varioptic has developed a liquid lens technology: manipulating liquids in a cell enables to achieve complex optical functions like focus, tilt and higher order corrections. These functions can be used to focus a camera, to correct the handshake blur, or even manipulate light from sophisticated laser systems. Application are widely distributed through consumer and professional imaging, data capture, illumination, 3D capture and many other applications which are still to be invented…

The basics of Liquid Lens technology

Liquids are highly transparent, extremely flexible and without any optical defect. They have been used since decades inside the optical systems of high-end goggles or high-end camcorders. The innovation brought by our technology is to be able to change the liquid surface in a very precise and controlled way, using Electrowetting. In addition, liquids are by definition very flexible, thus requiring very low power consumption: a few millliwatts.

Electrowetting or how an electric field can shape a liquid interface:
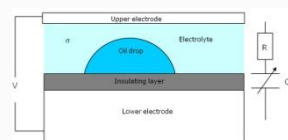
The voltage induces a change in the contact angle of the fluid on the surface, thus making the oil drop more prominent
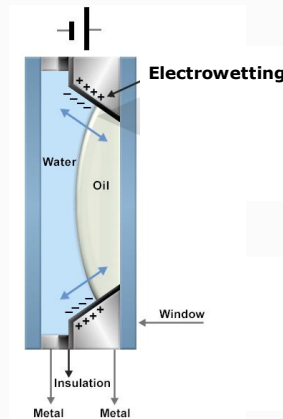

No voltage, the liquid drop is flat

Voltage increases at 30V

Voltage 60V, drop has "emerged"

The simplest liquid lens using the concept of Electrowetting: Arctic 316


Inside the cell, the 2 liquids are sealed: the liquid lens external shape is fixed. No moving part: only the liquids inside are changing shape.

Main advantages: robustness, speed, low power consumption

OIS liquid lens: A more sophisticated version of the liquid lens enabling higher order optical corrections: Baltic 617

The multi-electrode design, enabling driving the liquid interface to non symmetrical shapes:
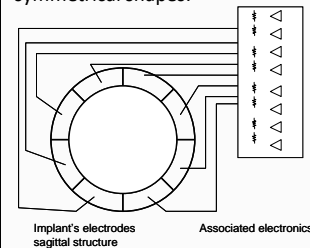
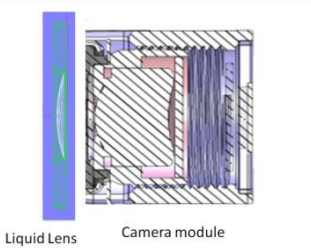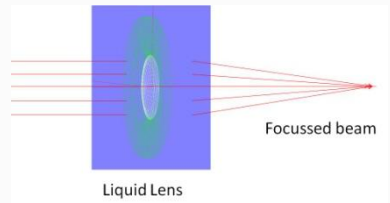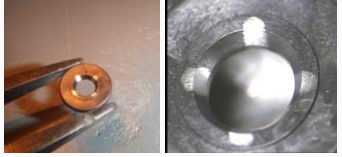_An example_ of 8 electrodes, achieving higher order aberrations corrections (astigmatism etc…):
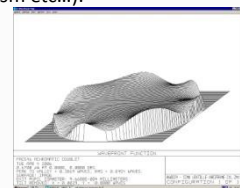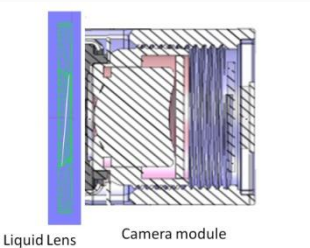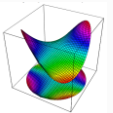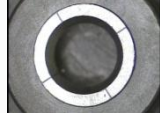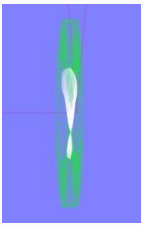
Another example : Baltic 617 for Optical Image Stabilization of handshake:

VARIOPTIC PROPRIETARY

What is it useful for?

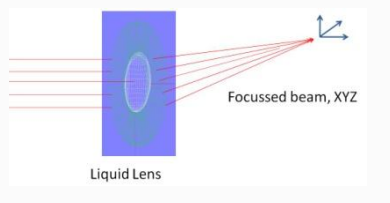Electrowetting enables to manipulate the liquid interface shape, in order to create various optical functions or optical corrections.

Single electrode lens: Liquid interface is a sphere, changing radius as a function of voltage	**4-Electrode lens**: Liquid interface is a sphere of adjustable radius + arbitrary tilts can be generated	**Multiple electrode lens** (8): the liquid interface can include Zernike corrections for: Sphere / Tilt / Cylinder (or astigmatism)

Single electrode lens — Fast focusing of the light for

Digital imaging applications:

- get faster a sharp image
- get faster multiple images at different focus positions, from infinity to 5cm object distance.
- reconstruct a 3D map from depth information of the scene.

Non-imaging applications:

- Laser focusing Z
- Laser de-cohering
- Light dispersing for illumination
- Longitudinal spectrometry

Product available: Arctic 316

4-Electrode lens — Fast focusing and tilting of the light beam for

Digital imaging applications:

- same as previous +
- improve low light capture
- correct for handshake in real time
- generate sub-pixel tilts for "super-resolution" multi acquisitions (zooming)
- generate astigmatism in one fixed direction: faster AF

Non-imaging applications:

- Laser focusing XYZ
- feedback loops for fine optical adjustments
- active control of beam deviations

Product available: Baltic 617

Multiple electrode lens — (only 4 electrodes are shown)

Digital imaging applications:

- Same as previous

Imaging for medical and ophthalmic instruments:

- correction of the main aberrations of the human eye
- improve retina imaging
- help the diagnosis of the corrections to be applied to vision
- microscopy

Non Imaging applications:

- correction of the lowest order Zernike components of the wave front aberrations, in hybrid adaptive optics
- wave front corrections in laser systems, including astigmatism
- control of 8th order polynomial corrections, in one fixed direction.

Liquid lens is the solution for fast and precise light manipulation: focus, tilt, astigmatism for imaging and non-imaging applications

VARIOPTIC PROPRIETARY

VARIOPTIC SA · Bâtiment Tony Garnier · 8b, rue Hermann Frenkel · 69007 LYON · Phone : +33 (0)437 65 35 31 · www.varioptic.com