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Optotune Liquid lenses for machine vision

Introduction

October 2019

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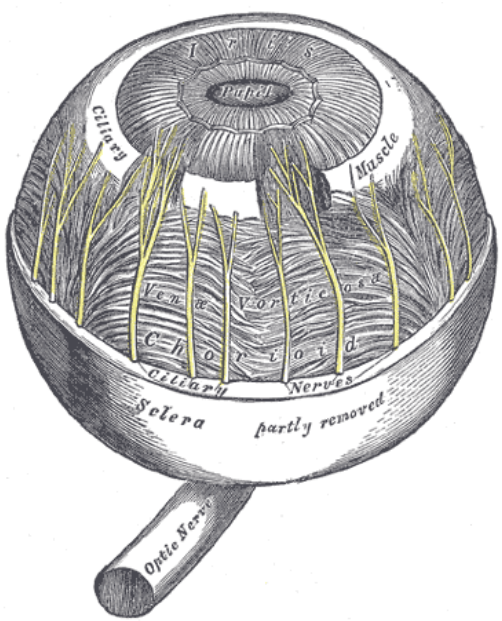
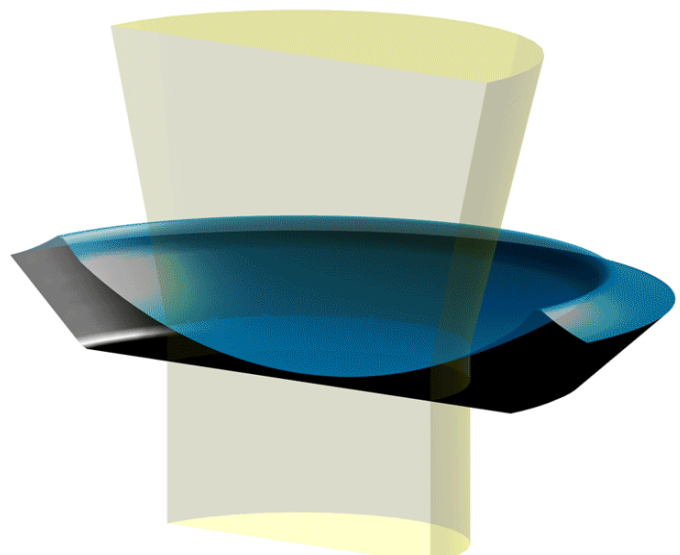
Working principle: membrane with fluid and actuator

Human eye:
Ciliary muscle actuates the lens curvature



Optotune lens:
Electromagnetic actuator controls the lens curvature



See also: https://www.optotune.com/technology/focus-tunable-lenses

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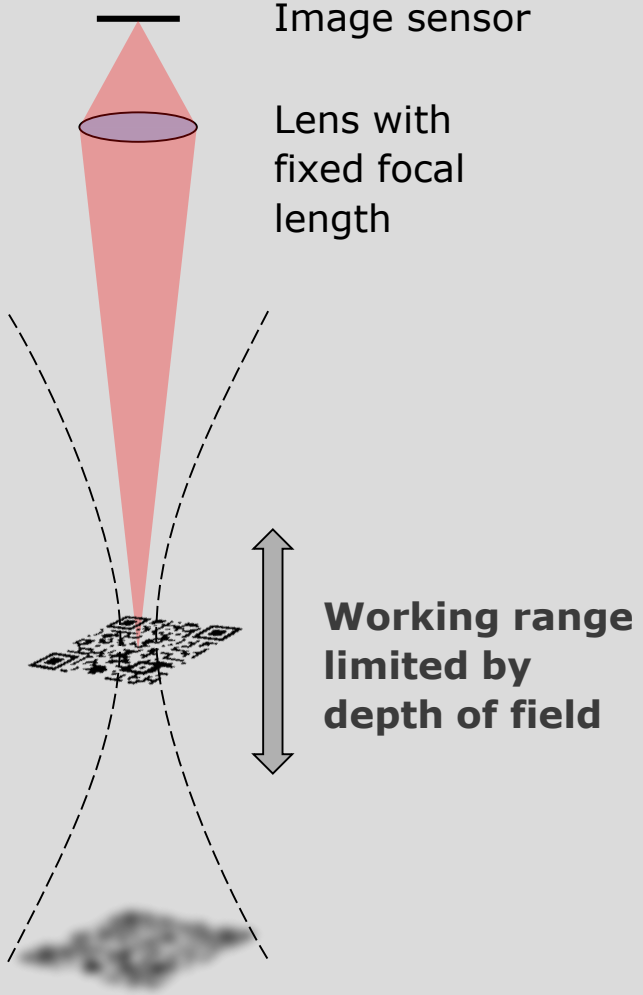
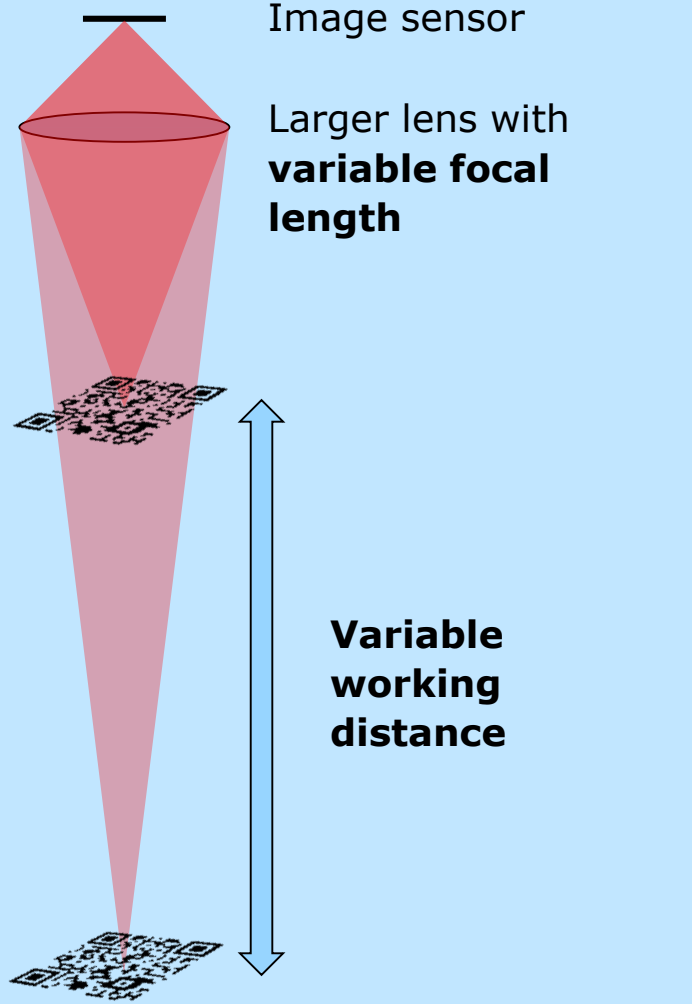
Benefits of Optotune lenses for machine vision

Fixed focus optics



Liquid lens approach



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Benefits of Optotune lenses for machine vision

Specification	System benefit
➢ Fast response time	✓ High throughput
➢ >10^9 cycles	✓ Long lifetime
➢ Repeatability <0.1 dpt (T comp.)	✓ One time calibration
➢ Apertures from 3 to 30mm	✓ Sensor size from 1/3” to 40mm
➢ Low dispersion (Abbe# V>100)	✓ Polychromatic applications
➢ Large working distance range	✓ No need to increase F# to get larger depth of field

Four main configurations for machine vision applications

Conventional fixed focal length lenses	Telecentric lenses	Microscopes

Front-lens config.

C- or S-mount lens

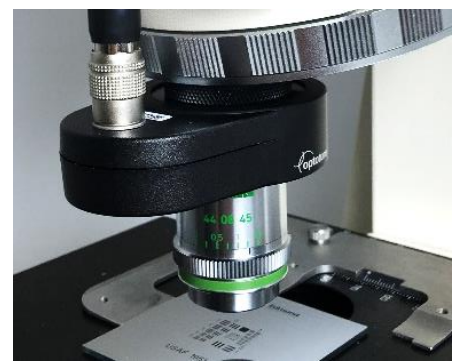
Working distances typically long (from 100mm to infinity)

Back-lens config.

Fixed focal length lens >=35mm

Working distances typically short (from 50mm to 500mm)

Magnifications: from 0.13X to 4X



Up to 100x magnification

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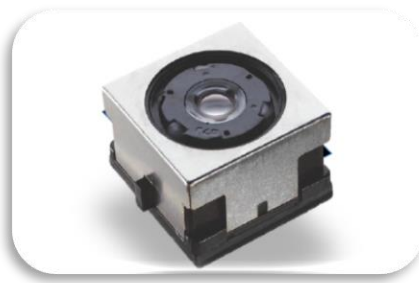
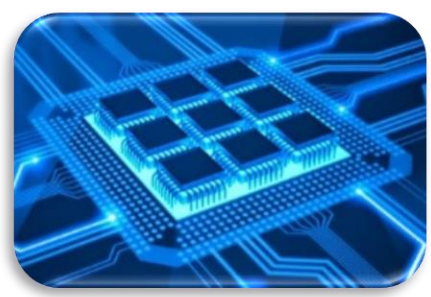
Four main configurations for machine vision applications

Conventional fixed focal length lenses		Telecentric lenses	Microscopes
Front-lens config. Large WD	**Back-lens config. Short WD**	**Constant magnification**	**High magnification**
Package sorting	Contact lens inspection	Camera phone lens inspection	Particle counting in liquids
			
Robot vision	Electronics inspection	IC inspection	Microscopy
			

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Configuration of the imaging system

Camera sensor	Mount	Imaging lens focal length (mm)										
		<6	6	8	12	16	25	35	50	75	100	>100
1/4”	S		30° HFOV	23°	15°	11°	7°	5°	4°	2.5°	2°	
	C											
1/3”	S		44°	33°	23°	17°	11°	8°	6°	4°	3°	
	C							**Front- or back lens configuration**				
1/2”	S		56°	44°	30°	23°	15°	10°	7°	5°	4°	
	C											
2/3”	C		73°	58°	40°	31°	20°	14°	10°	7°	5°	
1”	C		74°	77°	56° *	44° **	29° **	21° *	15° *	10°	7°	
30mm diag.	M42		128°	114°	91°	75°	52°	39°	28°	19°	14°	
		Front lens configuration only					**Back lens configuration only**					

Not possible

Possible with custom optics design

* Custom design available

Vignetting with off-the-shelf lenses

Possible with off-the-shelf lenses

** Customized lens in development

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Custom design example: 12 mm lens by VST

Short working distance, high resolution and **large field of view (FOV)** at the same time

- Ideal for code reading and OCR applications, e.g. in logistics

Lens: VST VS-LQ12H11, 12 mm lens with integrated EL-16-40-TC-VIS-5D

Camera: IDS UI-3200SE-M-GL, 1.1”, 3.45um px size, 4104x3004 px

Driver: Optotune lens driver 4

Note: Available with flex cable (as shown) or with industrial Hirose connector

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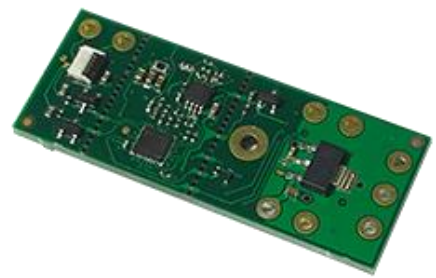
Plug and play with driver and software

	Optotune Lens Driver 4i	Gardasoft TR-CL180	Gardasoft CL191
			
Application	R&D, portable systems	Industrial 24/7 operation	OEM
Current range	-290 to + 290 mA	-400 to +400 mA	-250 to +250 mA
Supply voltage	5 V	24 V	3.3 or 5 V
Interfaces	USB	GigE, RS232, Analog	I2C, UART, Analog
SDKs	C#, LabVIEW	Triniti SDK, C#, C++, VB	C#, C++, VB

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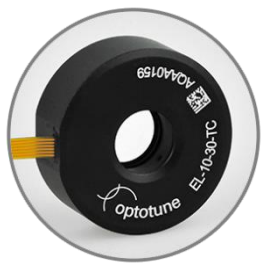
Optotune's liquid lenses for machine vision

	EL-10-30-TC	EL-10-30-C(i)	EL-16-40-TC
			
Focal power range	8 … 22 Dpt	-1.5 … +3.5 Dpt +5 … +10 Dpt	-2 … +3 Dpt -10 … +10 Dpt
Clear aperture	10mm	10mm	16mm
Outer diameter	30mm	30mm	40mm
Response time*	4 / 9 / 20 ms	2.5 / 6 / 15ms	5 / 12 / 25ms
Wavefront quality RMS @525nm**	<0.25 / 0.5 λ	<0.15 / 0.25 λ	<0.25 / 0.5 λ <0.25 / 1.5 λ
Absolute focal power accuracy (typical)	< 0.1 dpt	< 0.1 dpt	< 0.05 dpt
Typical use case	Microscopy	Small and mid size sensors	Large sensors

* 10-90% of step / settling time of a controlled step / settling time of rectangular step

** vertical / horizontal optical axis

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Summary

- Liquid lens working principle is based on the human eye
- Lenses have high working distance range, are reliable and straight forward to use
- Different configurations enable a broad range of imaging applications
- Lens configurator to identify imaging system components
- VST 12 mm lens has a large field of view with high resolution
- Drivers are available with interfaces for R&D and industrial applications