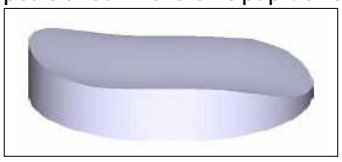
Optics | Technology Offer

Adaptive Phase Plates
For Focus Invariant Optical Systems

Market Requirements

With conventional optical systems it is not possible to achieve on the one hand a high depth of focus and on the other hand high lateral resolution and high light intensity.

To improve the depth of focus, there are currently image processing systems on the market which work using phase plates which operate on the basis of wavefront coding. The
phase plates used in these applications are cubic and are positioned in the exit pupil of the imaging system.



Cubic Phase Plate

The picture is recorded out of focus. By inverse filtering using appropriately tuned phase plates, the image can be restored and the depth of focus increased substantially. It is possible to improve depth of focus by a factor of up to seven. However, this negatively affects the contrast of the digital image. While the contrast can be improved by passing through an inverse digital filter, this procedure also increases the noise.

The increased depth of focus is also achieved at the cost of a reduction in the useful field of view within which the object is in focus.

Fields of Use

- Measurement instrumentation
- Fingerprint sensors
- Microscopy, endoscopy
- Simple and inexpensive lenses
  (e.g. for mobile phones or digital cameras)
- Bar code scanner

Advantages

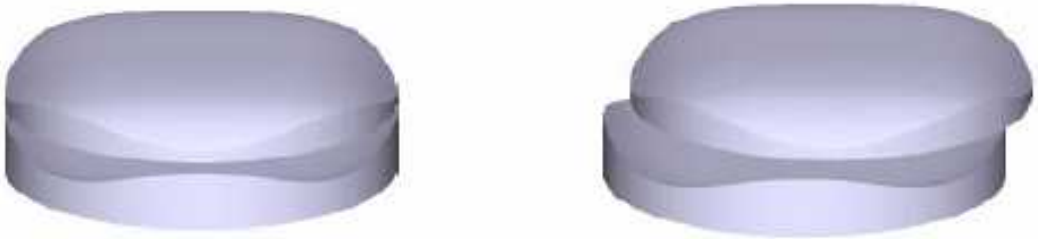
- Adjustable
- Inexpensive construction
  (e.g. plastic moulded optics)
- High depth of focus
- High light intensity
- High resolution

For this reason it is necessary to choose the depth of focus according to the image and lens characteristics. In practice this means that because of the fixed nature of cubic phase plates additional phase plates would have to be inserted, a difficult and expensive process.

The Invention of the Adaptive Phase Optics

The innovation described here offers an attractive alternative. Instead of the fixed cubic phase plate, variable phase plates are being used. An adaptive phase plate is made up of two phase plates which have especially shaped surfaces. These two phase plates are mounted one on top of the other and in the initial position, their respective actions compensate each other. When the two phase plates are moved relative to each other, the effect of the two phase plates is identical to that of a cubic phase plate (see below).

Adaptive phase plates act in the same way as cubic phase plates, however they can be adjusted by shifting them laterally



The effective cubic proportion increases as the plates are moved further away from the initial position. The displacement is of the order of a few tenths of a millimetre and can be adjusted continuously to achieve the desired cubic effect.

Adaptive phase plates allow in this way to realise the effect of cubic phase plates of variable strength and high precision. In this way, it becomes possible to adjust the complementary characteristics of depth of field and contrast in an optimal way for any given situation.

Fields of Use

The invention is particularly suitable for situations where for example three dimensional objects are to be imaged with minimal blurring or the need for precise adjustment of the optics to achieve sharp focus is to be kept to a minimum.

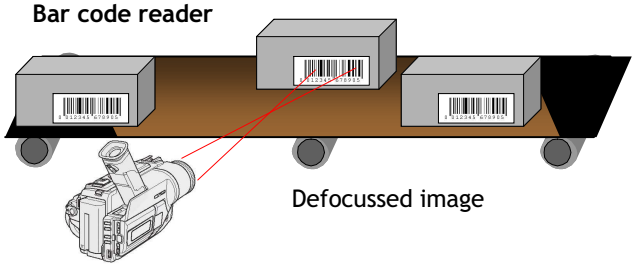
Possible applications include bar code scanners which have to recognise the bar code on objects of different sizes and at varying distances.

In the security technology, the adaptive phase optical system is suitable for inclusion in optical systems to record fingerprints. Furthermore, the system is highly suitable for inclusion in microscopy and endoscopy instruments

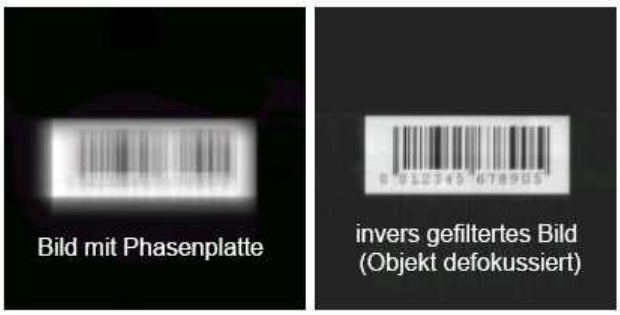
Additional Offer: Software PHYOS

For the optimisation of the design of focus invariant systems, researchers at the Fachhochschule Aalen developed the simulation program PHYOS (**Phy**sico **O**ptical **S**imulation). The program simulates the imaging of phase objects as well as amplitude objects. These can be either modelled mathematically or read in directly as images.

Example of application of adaptive phase plates:
Bar code reader



Defocussed image



Patent Portfolio

An European patent application is grant (EP 1 445 640 B1). The European patent is valid in AT, CH, DE, FR and GB.

Technology Transfer

The invention originates from the Fachhochschule Aalen, Germany. TLB GmbH has been charged with its commercialisation and is offering suitable companies the opportunity to acquire a licence.

Prototype

The Institute for Applied Research will support commercialisation partners with know-how and in the further development work.
A prototype can be build.
Existing mould for plastic optic prototypes.

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Design optimisation of a focus invariant system using the simulation program PHYOS