

# Holographic optical element and its manufacturing method

## Conversion of depth information linearly into planar information!

### Overview

In 3D imaging, it is important to effectively encode  $z$  information, which is the image formation displacement of the target object, into  $XY$  information, which is displacement from the optical axis of the image surface. On the other hand, in single-pixel imaging using only a single detector, it is important to encode in efficient manner the  $XY$  information of the target into the time information. However, the conventional encoding method has a limit on distance resolution, imaging distance range,  $z$  information decoding accuracy and encryption uniqueness.

This invention provides a new and improved hologram optical element, its manufacturing method and an optical device able to mutually convert  $Z$  &  $XY$  information with simple configuration. This invention is able to realize high accuracy and high spatial resolution for high-speed 3D imaging (patent US10816474) by converting the object depth direction information of the optical detection system into the planar direction information at the detecting surface.

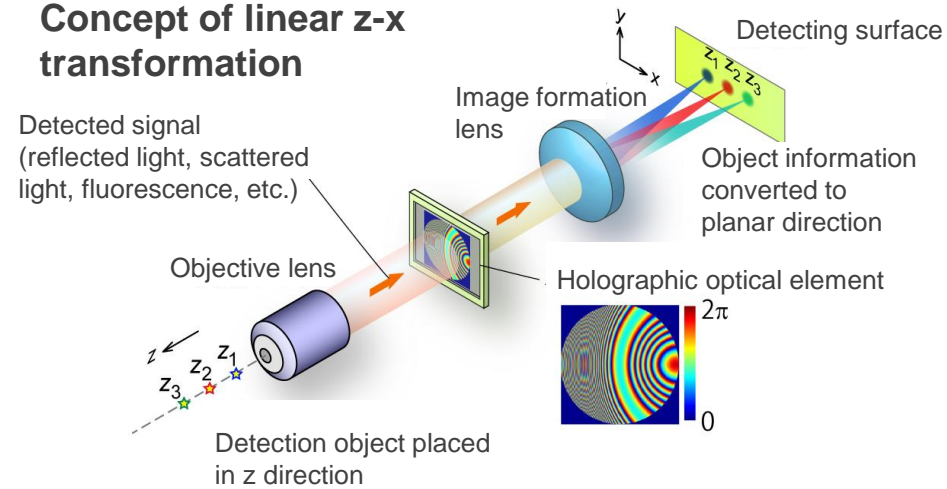
### Product Application

- ❑ Optical field such as optical microscope
- ❑ Fast sensing for depth direction in 3D space

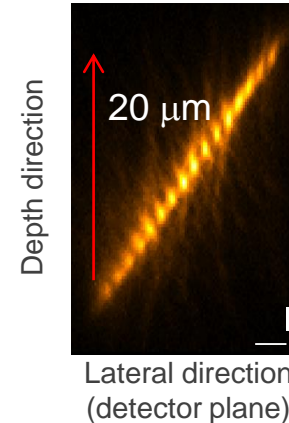
### IP Data

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 Admin No. : T17-106

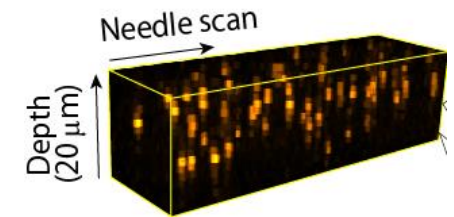
## Concept of linear $z$ - $x$ transformation



### Demonstrated linear shift behavior



### Video-rate 3D acquisition



- The image position in the detecting surface shifts linearly in the planar direction according to the object depth position.
- Axial position is retrieved without further calibration processes.

### Related Works

- [1] T. Nakamura et al., Opt. Lett. **43**, 5949 (2018).
- [2] Y. Kozawa et al., Biomed. Opt. Express **13**, 1702 (2022)
- [3] [Press release \(Tohoku Univ.\)](#)

### Contact