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Matched Spatial Filtering of Phase Objects with Liquid Crystal on Silicon Device

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In our early study, we have developed an apparatus for optically and automatically recognizing particular shapes in the image. This system has a coordinate transformation processing and matched filtering, and can recognize the shape even if the size and the rotational angle of the target shape change. Furthermore, We achieved lensless optical computing by using the liquid crystal on silicon (LCoS) device, and could be carried out at the same time matched filter and coordinate transformation processing by using different wavelengths of light. Lensless matched filter and optical coordinate transformation processing has been achieved by displaying computer-generated hologram (CGH) on the LCoS. The optical matched filtering has the shift invariant characteristic, which the recognition performance does not change for object translation. However, recognition ability significantly degrades by changes in rotational angle and size. Therefore, rotation and size invariant including shift invariant optical shape recognition system was acheived by the optical coordinate transformation that converts rotation and scale variation into translation. However, this system can be used only to amplitude objects, which have only an amplitude transmittance.

We have been developing the method of measuring the number and the position of a specific phase object such as a biological tissue with wide measurement view. Applying the phase-contrast technique and the optical matched filter to the Fourier transform image of the phase object, the target phase object is converted into the amplitude distribution and involves its correlation signal. We aim to develop the system that can flexibly cope with various shapes by making the Fourier filter with the LCoS display. In our system, the polystyrene latex particles with 20 μm diameter, which were displayed as dark holes in the ordinary transmittance image (Fig.1), were converted into bright particles in the phase-contrast mode (Fig.2).

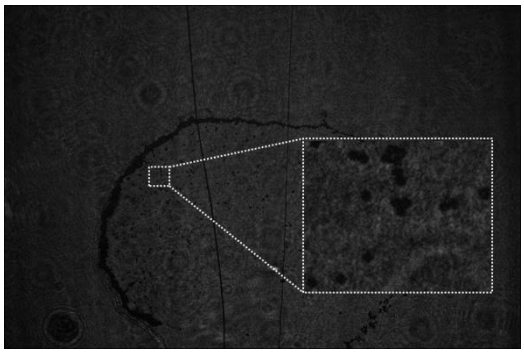

Fig.1　The ordinary transmittance image of polystyrene latex particles

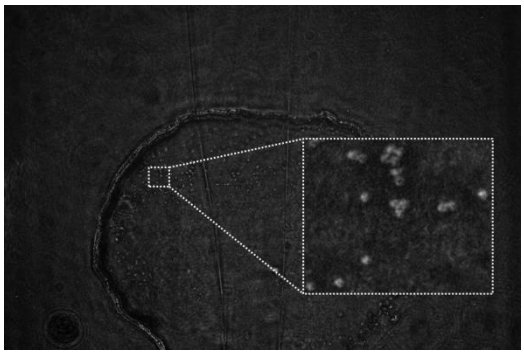

Fig.2　The phase-contrast image of polystyrene latex particles