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Experimental demonstration of Fourier-domain single-phase decryption scheme

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Abstract: An experimental demonstration for the phase-only optical decryption based on kinogram encoding is proposed.The encrypted information and the decrypting key are produced on a same phase spatial light modulator with the large active area. The decrypted intensity image is reconstructed through the Fourier transform of the phase decrypted image.

There has been considerable effort to develop optical encryption schemes: Javidi and co-workers [1] have been responsible for proposing the use of phase masks to scramble and encrypt amplitude information. More recently, this system architecture was modified by the replacement of the amplitude information at the input with phase-encoded information.[2]

The problem with these systems is that they use information encoded in both amplitude and phase regimes, hence often requiring the fabrication of complex optical masks. Mogensen and Gluckstad [3] proposed an alternative approach based on the direct mapping of an encrypted phase mask and a decrypting phase key, resulting in the decryption of information completely within a phase-only domain. However, their system uses a phase-contrast filter with a 4-f setup to convert decrypted phase information into amplitude image which can be captured by intensity-sensitive devices. In our previous work,[4] we proposedan alternative decryption scheme which is simpler and is more easily realized than that of Mogensen et al. The experimental demonstration of that scheme is presented in this paper.

In our approach, the encrypted informationwas produced as follows. First we generate a kinogram of the original image needed to be encrypted. The kinogramhas phase elements with relative phase shifts of 0 or . We optimize that kinogram with a direct binary search algorithm. Second, the optimized kinogram was electronically scrambled with a random phase-only pattern to produce the encrypted information. The method for decryption is the same as that for encryption but in the reverse direction. That is, the encrypted information is descrambled with the conjugation of the random pattern used in the encryption process.To extract the original intensity image, we Fourier transform the descrambled information. In practice, it can be simply implemented with a single Fourier lens.The decryption scheme is shown in Fig. 1.

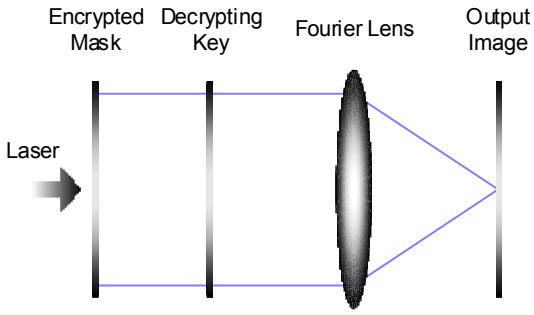

Figure 1. Decryption scheme with Fourier lens.

The decryption scheme isimplemented with the aid of phase spatial light modulator (SLM). Figure 2 shows our setup by use of a single SLM with large active area. The laser beam is expanded and collimated by a micro objective lens and an ordinarylens, respectively. One half of the SLM panel modulates the laser beam in phase according to the encrypted information, and the other half descrambled the modulated beamto extract the original information that is actually the kinogram. The lens in the output is used to convert the kinogram into intensity information.

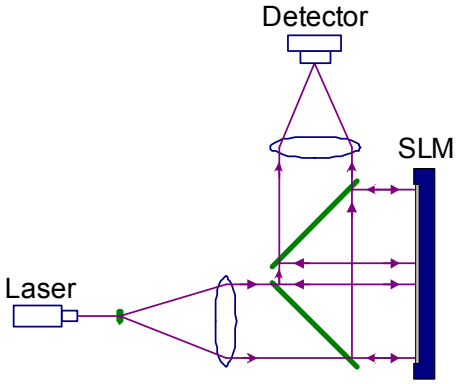

Figure 2. Experimental setup

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