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Non-line-of-sight optical communication using 1D Speckle Information

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One-to-three non-line-of-sight optical communication channels employing Orbital angular momentum-Shift keying (OAM-SK) based on 1D speckle information are established with an average classification accuracy of 79% among all three channels.

Realizing the potential of OAM beams in free space optical communication by employing space-division multiplexing [1-4], we have established a one-to-three non-line-of-sight (NLOS) free space optical (FSO) communication channel link using Laguerre-Gaussian (LG) beams. OAM-SK is used to encode a 3-bit greyscale image of 100×100 pixels resolution. LG beams passed through a diffuser giving rise to far-field speckle patterns that are captured at three different positions using a CCD camera, acting as receivers. One is along the beam axis (C2) and the other two are ±15° (C1 and C3) from the beam axis maintaining the same radial distance of 26cm. 1D speckle-based demultiplexing (SBD) [2-4] is used to demultiplex the encoded information at three different positions. From the captured intensity speckle images of 1200×1920 pixels, a 1D crossline array of size 1×1200 is mapped at random directions. A wavelet scattering network acting as a feature extractor is used to extract the scattering coefficients of the mapped crossline array and further fed to the 1D convolutional neural network (CNN) for training and testing. The 1D CNN trained on 80% of the mapped crossline arrays and tested on the remaining 20% of data, achieved 79%, 95%, and 63% classification accuracies at C1, C2, and C3 channels respectively. The trained network is deployed to reconstruct the original image in one-to-three NLOS communication channel links. The experimental setup along with the reconstructed image is shown in fig. 1.

Using 1D SBD to demultiplex the encoded information has enormously decreased the computational load and establishes an alignment-free demultiplexing technique in optics. The proposed 1D SBD scheme can be deployed in real-time with minimal computational resources. The classification accuracy can be improved further by employing other feature extraction techniques and building a deep neural network.

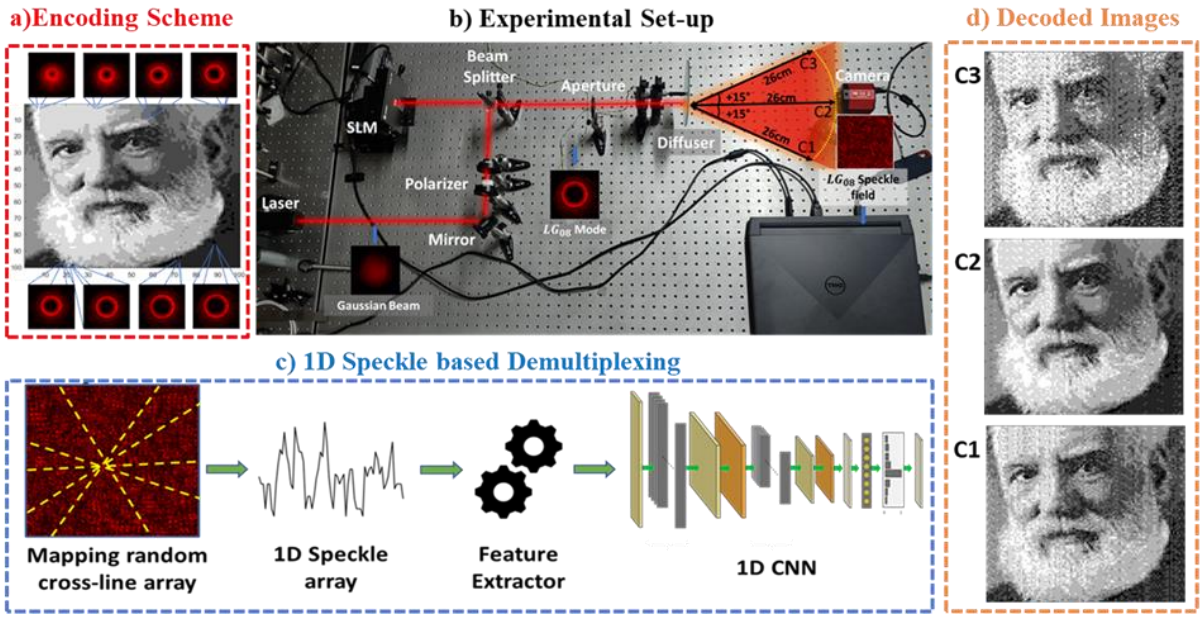

Fig. 1 a. OAM-SK encoding scheme. **b**. Experimental set-up for one-to-three NLOS FSO communication channel links. **c**. Data processing in 1D SBD scheme. **d**. Reconstructed images by using 1D SBD in C1, C2, and C3 channels respectively.

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