Since the angular measure has been quantised to 12 levels, and the radial distance to five levels, the number of input neurons is 60. Further, since the number of classes (of patterns) **is** 16, the number of output neurons is chosen to be four. The results of training the network are given in Table 1. Some samples of the exemplars used to train the network are given in Fig. 2.

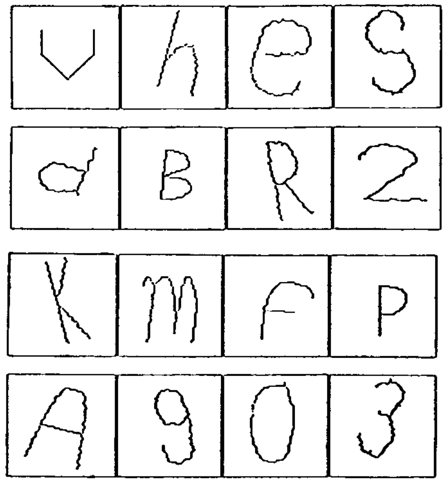

Fig. 2 ***Samples of test paterns from which input vector to neural network is calculated after preprocessing***

Table 1 indicates that, after 2000 iterations of training, the network misclassifies only 21 of the 8000 patterns; a success rate of more than 99%, which is an indication of the efficiency of the feature extraction procedure in the proposed scheme. An additional set of 8000 patterns (with and without noise) is created with a different seed value for the random-number generator to test the proposed technique. The testing is carried out several times and the details are given in Table 2.

Performance of coding scheme with noisy patterns: Noise, introduced by flipping (with a specified probability) the pixels, results in breaks and isolated dots in the pattern. The line approximation removes the isolated dots by rejecting short line segments. However, the breaks caused give rise to many more line segments, and new end and middle points of the line segments, thereby causing much deterioration in the performance of the proposed technique. By further preprocessing the patterns using simple morphological techniques such as dilation followed by thinning, the breaks in the patterns can be minimised and the performance of the proposed technique vastly improved. Table 2 gives the performance results of the proposed technique compared to noiseless patterns, noisy patterns and preprocessed noisy patterns using morphological techniques.

Table *2* Percentages of correct classification by proposed technique for various cases

Types of patterns	Test data 1	Test data 2	Test data 3	Test data 4	Test data 5
noiseless	97.6	97.1	97.1	97.67	97.1
10% noise	68.0	67.5	67.3	68.3	68.2
20% noise	41.3	41.5	41.0	40.8	41.8
10% noise + morphology	92.7	92.6	92.8	93.0	92.7
20% noise + morphology	89.7	90.3	89.3	90.1	89.9

Conclusions: **A** new, efficient method for encoding patterns has been proposed to provide a feature vector as an input to an artificial neural network (ANN) for classification. Feature vector extraction involves approximation of the given pattern by straight lines, followed by the extraction of the corner points along with the centre points of the line segments. These features are then overlaid on a radial grid of cells to form the input array to the BN. The results obtained show the efficacy and robustness of the proposed technique, complete details of which will appear in [5].

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C.N.S. Ganesh Murthy and Y.V. Venkatesh ***(Computer Vision and Artificial Intelligence Laboratory, Department of Electrical Engineering, Indian Institute of Science, Bangalore-560012, India)***

References

1 FUKUSHIMA, K., and WAKE, N.: 'Hand written alphanumeric character recognition by the neocognitron', *IEEE* ***Trans. Neural Netw.***, 1991, **2,** pp. 355–365

2 YOU, S.D., and FORD, G.E.: 'Network model for invariant object recognition', ***Pattern Recognit. Lett.***, 1994, **15,** (8), pp. 761–768

3 PERANTONIS, **SJ**, and LISBOZ, **PJ.G** : 'Translation, rotation, and scale invariant pattern recognition by high-order neural networks and moment classifiers', ***IEEE Trans. Neural Netw.***, 1992, ***3,*** (2), pp. 241–251

4 LeCUN, Y., BOSER, B., DENKER, J.S., HENDERSON, D., HOWARD, R.E., HUBBARD, **W.,** and JACKEL, L.D.: 'Hand written digit recognition with a back-propagation network', ***in*** 'Advances in neural information processing systems 2' (Morgan Kaufmann, San Mateo, CA), pp. 396–404

5 GANESH MURTHY, C N S., and VENKATESH, **Y V** : **'A** new method for encoding patterns for classification by neural networks'. submitted to *IEEE* ***Trans. Neural Netw.***

2.5 Gbit/s transmission of spectrum-sliced fibre amplifier light source channels over 200 km of dispersion-shifted fibre

Jung-Hee Han, Jae-Seung Lee, Sang-Soo Lee, Tae-Yeoul Yun, Hyang-Kyun Kim, Chang-Hee Lee and Sang-Yung Shin

Indexing ***terms: Fibre amplifiers,*** **Optical communication**

Transmission of 2.5 Gbit/s spectrum-sliced fibre amplifier light source channels over 200 km of dispersion-shifted fibre (DSF) has been achieved, the highest bit-rate distance product 500 Gbit/s km using incoherent light sources reported to our knowledge. The total power penalty was as low as 0.2 dB for the 1.8 nm bandwidth channel centred at the zero-dispersion wavelength of **DSF.**

Introduction: Recently, spectrum-sliced fibre amplifier light sources have been proposed for wavelength division multiplexed (WDM) systems [1, 2]. Such sources launch high optical powers inside the transmission fibre with negligible stimulated Brillouin scattering [3] and may allocate WDM channels at desired positions using passive optical filters. Contrary to coherent laser diodes, the optical bandwidth should be far larger than the transmission bit rate. Thus, its application was focused mainly on local-loop networks limited by the optical fibre dispersion. However, recent experiments show that the bit-rate distance product of the spectrum-sliced channel can be increased beyond local-loop applications [4, 5]. Moreover, with newly developed dispersion compensation techniques [6], the dispersion of the spectrum-sliced channels can be greatly reduced. The spectrum-sliced channels have been transmitted over 60km of non-dispersion-shifted fibre at 622 Mbit/s with 0.23 nm bandwidth [4] and over 165 km of dispersion-shifted fibre (DSF) at 1.7 Gbitis with –1.2 nm channel bandwidth [5].

We demonstrate 2.5 Gbit/s transmission of the spectrum-sliced channels over 200 km of DSF. To our knowledge, this **is** the fastest and the longest transmission experiment using incoherent light sources with a hit-rate distance product of 500 Gbit/s km. The total power penalty was as low as 0.2 dB for the 1.8 nm bandwidth channel centred at the zero-dispersion wavelength of DSF.

Experiment: The experimental setup is shown in Fig. 1. Three erbium-doped fibre amplifiers were used (EDFA1, EDFA2 and EDFA3). The amplified spontaneous emission light from EDFA1 was spectrum-sliced using a tunable optical bandpass filter denoted by BP1. The bandpass filter was tuned at 1557 nm with a 3dB channel bandwidth of 1.8 nm. The ASE power was 7 dBm