Guest Editorial

At one time, image processing was considered too complex, compute-intensive, and expensive to be handled by the most sophisticated computer systems. It had limited applications in military surveillance and guidance systems. In the past decade,the requirement of high performance image applications necessitated the use of computational capabilities and speed of the world's most powerful computer systems. The recent growth of computer industry has made it possible for technologies like image processing to become both widespread and affordable. The technology has gracefully moved from supercomputers to personal workstations. Today, image processing has a variety of applications like remote sensing, medical imagery, surveillance, visualisation, fingerprint matching, and industrial inspection. This Special Issue of *Defence Science Journal* is devoted to defence applications of image processing and contains 11 papers.

Image registration is a fundamental task in image processing. It is used to match two or more images taken, for example, at different time, from different sensors, or from different viewpoints. Virtually all large systems, which evaluate images, require the registration of images, or a closely related operation, as an intermediate step. Specific examples of systems, where image registration is a significant component, are matching a target with a real-time image of a scene for target recognition, monitoring global land usage, matching stereo images to recover shape for autonomous navigation, and aligning images from different medical modalities for diagnosis. The focus of the first three papers is, therefore, on image registration.

The first paper by Majumdar and Dilip discusses the computation time, accuracy, and probability of error in obtaining matches of image registration algorithms in real-time target tracking. The study shows that using smoothing and a reduced time step in the computation, the predicted target position during occlusion almost follows the actual observations, during flight trial of unmanned aerial vehicle.

Whereas in target tracking in real-time, there may be few variant structures in seasonal-variant radar images, the majority of images change. For some defence applications, focus on detecting few invariant structures is essential. Rakshit and Deodhare in their paper present a registration technique that works under the constraints posed by seasonal-variant radar images. The algorithm, in various cost performance configurations, is tested on a set of ERS radar images.

The error, which is always introduced when an image is taken remotely by an imaging system, is particularly prominent in images taken by satellite or by a camera mounted on an airborne platform. The error is generally a composite of translation, rotation, scaling, as

well as warping, and is known as geometric error. The paper by Panigrahi and Tripathy discusses various aspects related to the geometric errors observed in a satellite image and transformation that can be applied to remove these errors.

Recognition of objects, irregular in structure, according to notions of conventional Euclidean geometry, is a challenging problem of practical utility. Spurred by the problem of identifying surface imperfections in fuel pellets, Kar and Chandran present a morphological learning-based object recognition technique, which works irrespective of the geometric structure of the objects. The technique shows promise in applications of computer vision for identification of patterns having irregular Euclidean structures.

Terrain elevation data is also irregular in nature. Triangular irregular network is, therefore, used to generate terrain elevation data required for the three-dimensional modelling of satellite imagery. Porwal, *et al.* in their paper present a search and render algorithm that calculates the visible objects, depending on the viewing direction and the viewpoint parameters, and draws only visible objects in the three-dimensional frame. As soon as viewing parameters change, the algorithm re-calculates the objects and draws these objects in the new frame. This algorithm provides a consistent frame rendering performance, which is independent of the size of dataset. However, more efforts are needed to extend this algorithm to handle high altitude rendering, which is of vital importance.

Content-based spatial similarity can be used to locate spatial relationships among various objects in a specific area from the aerial photographs and to retrieve the images similar to the query images from the image database. The paper by Kulkarni and Joshi presents an algorithm for retrieving images by spatial similarity from the image database by utilising both directional and topological relations even after the images undergo modelling transformation.

An important task in image processing is the segmentation of images based on image properties, eg, texture for biomedical imaging, or colour for natural scenes. Jha and Hanmandlu present a concept of defining a mountain function at each element of the dataset, i.e., a set of all possible colours in a given image, which forms a potential cluster. The strength of this function is calculated as a function of distance of neighbouring elements. On the basis of the strength, it is declared as a cluster and its effect is removed from all other data elements. Subsequently, another element is chosen as next potential cluster centre. This procedure is repeated until a validity criterion comprising a ratio of compactness of the clusters to the separation among the clusters is violated. The results are comparable to results of fuzzy C-means technique, and are computationally more efficient.

Computed tomography may be used for non-destructive evaluation of large objects. However, obtaining required projection data for large objects may not be possible due to limitations in size of scanners. The paper by Suneet Singh, *et al.* explores the possibility of image reconstruction using incomplete data obtained from such scanners. The projection data can be calculated mathematically for geometrically simulated specimens. The study shows that there is a marked improvement in the reconstructed images using combination

of algebraic reconstruction technique (ART) and convolution back projection (CBP) algorithm over those using ART alone.

Medical imaging is a vital component of large number of applications. The paper by Tripathi, *et al.* discusses the enlargement of one-dimensional parallel projection (with varying number of rays per projection) for image reconstruction using interpolation techniques to improve the quality of images and reduce the data acquisition time. The reconstructed image facilitates enhanced image visualisation in computed tomography images.

Indexing of image databases for retrieving content information from images in response to queries is addressed in the paper by Joshi and Tapaswi using wavelet decompositions and image distance metric based on pair-wise comparison of the stored wavelets. The performance of the proposed algorithm depends on the image size and the window size.

The paper by Negi, *et. al.* describes the change detection system developed to extract changes in the panchromatic images using the domain knowledge of the photo interpreter. The work is planned to be extended to describe and analyse the changed region automatically.

We are grateful to the authors and the referees for their cooperation which has enabled us to present these papers to the image processing community interested in applications of particular interest to Defence. We are also grateful to Director, DESIDOC and his colleagues for giving us this opportunity which reinforced our interest in image processing which we started with the COMTAL image processing system in the erstwhile DRDO Computer Centre, Delhi. Subsequently, we realised the importance of satellite imagery for validating the output of the Cray supercomputer for medium-range weather forecasting. Thereafter, we also worked as catalysts to bring together all our colleagues in DRDO concerned with satellite imagery with the ambitious hope of nucleating an integrated geographical information system. We will consider our efforts in guest editing this Special Issue rewarded if it leads to fruitful collaborative effort by all researchers in image processing, which is of vital importance to the nation.

SS Prasad
Director
Neelam Bhalla, Scientist 'E'
Recruitment & Assessment Centre
Defence Research & Development Organisation
Delhi – 110 054