# Image Registration and Restoration from Multiple degraded colour images

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**Abstract- Today most of the smartphones like iPhone encompasses a distinctive feature of capturing pictures in Panorama read, have you ever ever thought what this system is? this can be the results of image restoration, and this half is technically known as image mosaicing. This paper aims to gift a review of recent still as classic image registration strategies. Image registration is that the method of positioning 2 or additional pictures of an equivalent scene taken at totally different times, from totally different viewpoints, and/or by totally different sensors. This method involves designating one image because the reference (also known as the reference image or the mounted image), and applying geometric transformations to the opposite pictures so they align with the reference. taken at totally different times, from totally different viewpoints, and/or by totally different sensors.**

**Index Terms-- Image registration; Image Restoration`; Feature detection; Feature matching; Mapping function; Resampling; co-ordinate system, correspondence.**

## I. INTRODUCTION

Image registration is that the method of overlaying 2 or additional pictures of an equivalent scene taken at totally different times, from totally different viewpoints, and/or by totally different sensors. It geometrically aligns 2 pictures—the reference and detected images. Image registration could be a crucial step altogether image analysis tasks during which the final info is gained from the mix of assorted knowledge sources like in image fusion, modification detection, and multichannel image restoration. Typically, registration is needed in remote sensing (multispectral classification, environmental observation, modification detection, image mosaicing, meteorology, making super-resolution pictures, group action info into

geographic info systems (GIS)), in drugs (combining pc picturing (CT) and NMR knowledge to get additional complete info regarding the patient, observation growth growth, treatment verification, comparison of the patient's knowledge with anatomical atlases), in making (map updating), and in pc vision (target localization, automatic quality control), to call many. The intention of our article is to hide relevant approaches introduced later and during this method map the present development of registration techniques.

## II. IMAGE REGISTRATION METHODOLOGY

In general, its (image registration) applications can be divided into four main groups according to the manner of the image acquisition:

*Different viewpoints* (multiview analysis). Images of the same scene are acquired from different viewpoints. The aim is to gain larger a 2D view or a 3D representation of the scanned scene. For example Remote sensing—mosaicing of images of the surveyed area. Computer vision—shape recovery (shape from stereo).

*Different times* (multitemporal analysis). Images of the same scene are acquired at different times, often on regular basis, and possibly under different conditions. The aim is to find and evaluate changes in the scene which appeared between the consecutive image acquisitions. For example Remote sensing—monitoring of global land usage, landscape planning. Computer vision—automatic change detection for security monitoring, motion tracking. Medical imaging—monitoring of the healing therapy, monitoring of the tumor evolution.

*Different sensors* (multimodal analysis). Images of the same scene are acquired by different sensors. The aim is to integrate the information obtained from different source streams to gain more complex and detailed scene representation. For example Remote sensing—fusion of information from sensors with different characteristics like panchromatic images, offering better spatial resolution, color/multispectral images with better spectral resolution, or radar images independent of cloud cover and solar illumination. Medical imaging—combination of sensors recording the anatomical body structure like magnetic resonance image (MRI), ultrasound or CT with sensors monitoring functional and metabolic body activities like positron emission tomography (PET), single photon emission computed tomography (SPECT) or magnetic resonance spectroscopy (MRS).

*Scene to model registration*. Images of a scene and a model of the scene are registered. The model can be a computer representation of the scene, for instance maps or digital

elevation models (DEM) in GIS, another scene with similar content (another patient), 'average' specimen, etc. The aim is to localize the acquired image in the scene/model and/or to compare them. For example Remote sensing—registration of aerial or satellite data into maps or other GIS layers. Medical imaging— comparison of the patient's image with digital anatomical atlases, specimen classification.

Though there is no universal registration method but the majority of the registration methods consists of the following four steps (see Fig. 1):

- *Feature detection*. Salient and distinctive objects (closed-boundary regions, edges, contours, line intersections, corners, etc.) are manually or, preferably, automatically detected. For further processing, these features can be represented by their point representatives (centers of gravity, line endings, distinctive points), which are called control points (CPs) in the literature.
- *Feature matching*. In this step, the correspondence between the features detected in the sensed image and those detected in the reference image is established. Various feature descriptors and similarity measures along with spatial relationships among the features are used for that purpose.
- *Transform model estimation*. The type and parameters of the so-called mapping functions, aligning the sensed image with the reference image, are estimated. The parameters of the mapping functions are computed by means of the established feature correspondence.
- *Image resampling and transformation*. The sensed image is transformed by means of the mapping functions. Image values in non-integer coordinates are computed by the appropriate interpolation technique.

After certain complexities in feature detection in an ideal case, the algorithm should be able to detect the same features in all projections of the scene regardless of the particular image deformation.
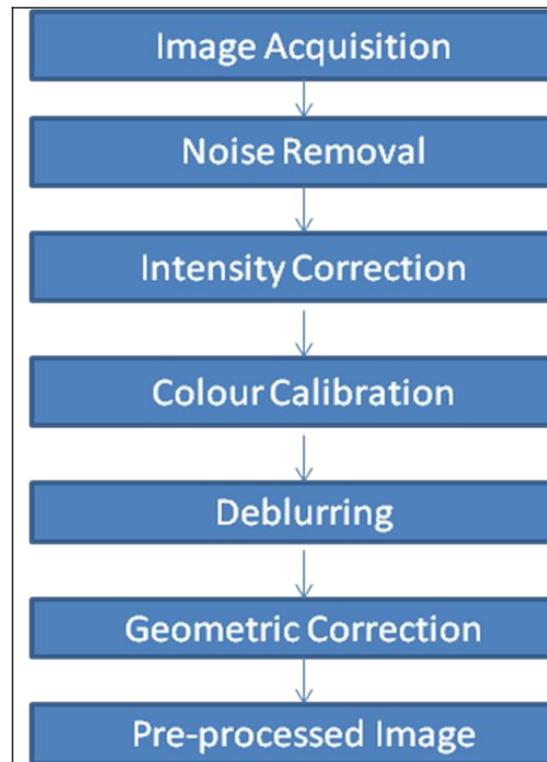




*Fig. 1. Four steps of image registration: top row—feature detection (corners were used as the features in this case). Middle row—feature matching by invariant descriptors (the corresponding pairs are marked by numbers). Bottom left—transform model estimation exploiting the established correspondence. Bottom right—image resampling and transformation using appropriate interpolation technique.*

In the feature matching step, problems caused by an incorrect feature detection or by image degradations can arise. Physically corresponding features can be dissimilar due to the different imaging conditions and/or due to the different spectral sensitivity of the sensors. The feature descriptors should be invariant to the assumed degradations. Simultaneously, they have to be discriminable enough to be able to distinguish among different features as well as sufficiently stable so as not to be influenced by slight unexpected feature variations and noise.

The type of the mapping functions should be chosen according to the a priori known information about the acquisition process and expected image degradations. Finally, the choice of the appropriate type of resampling technique depends on the trade-off between the demanded accuracy of the interpolation and the computational complexity. The nearest-neighbor or bilinear interpolation are sufficient in most cases; however, some applications require more precise methods.

Registration methods can be categorized with respect to various criteria. The ones usually used are the application area, dimensionality of data, type and complexity of assumed image deformations, computational cost, and the essential ideas of the registration algorithm. Here, the classification according to the essential ideas is chosen, considering the decomposition of the registration into the described four steps. The techniques exceeding this four-step framework are covered according to their major contribution.

## III. FEATURE DETECTION

Formerly, the features were objects manually selected by an expert. During an automation of this registration step, two main approaches to feature understanding have been formed.

3.1. *Area-based methods:* Area-based methods put emphasis rather on the feature matching step than on their detection. No features are detected in these approaches so the first step of image registration is omitted. The methods belonging to this class will be covered in sections corresponding to the other registration steps.

3.2. *Feature-based methods :* The second approach is based on the extraction of salient structures–features—in the images. Significant regions (forests, lakes, fields), lines (region boundaries, coastlines, roads, rivers) or points (region corners, line intersections, points on curves with high curvature) are understood as features here.
*Region features*. The region-like features can be the projections of general high contrast closed-boundary regions of an appropriate size [32], water reservoirs, and lakes [29], buildings [30], forests [25], urban areas [28] or shadows [26].

*Line features*. The line features can be the representations of general line segments [27], object contours [28], coastal lines, roads or elongated anatomic structures in medical imaging.

*Point features*. The point features group consists of methods working with line intersections, road crossings [29], centroids of water regions, oil and gas pads, high variance points [31], local curvature etc.

## IV. FEATURE MATCHING

The detected features in the reference and sensed images can be matched by means of the image intensity values in their close neighborhoods, the feature spatial distribution, or the feature symbolic description. Some methods, while looking for the feature correspondence, simultaneously estimate the parameters of mapping functions and thus merge the second and third registration steps. There are two major categories:

4.1. *Area-based methods*
Area-based methods, sometimes called correlation-like methods or template matching [59] merge the feature detection step with the matching part. These methods deal with the images without attempting to detect salient objects. Several authors proposed to use circular shape of the window for mutually rotated images. However, the comparability of such simple-shaped windows is violated too if more complicated geometric deformations (similarity, perspective transforms, etc.) are present between images.

4.1.1. *Correlation-like methods*
The classical representative of the area-based methods is the normalized CC and its modifications.

$$CC(i,j) = \frac{\sum_W (W - E(W))(I_{(i,j)} - E(I_{(i,j)}))}{\sqrt{\sum_W (W - E(W))^2}\sqrt{\sum_{I_{(i,j)}}(I_{(i,j)} - E(I_{(i,j)}))^2}}$$

This measure of similarity is computed for window pairs from the sensed and reference images and its maximum is searched.
Recently big interest in the area of multimodal registration has been paid to the correlation ratio based methods. In opposite to classical CC, this similarity measure can handle intensity differences between images due to the usage of different sensors—multimodal images.

4.1.2. *Fourier methods*
If an acceleration of the computational speed is needed or if the images were acquired under varying conditions or they are corrupted by frequency-dependent noise, then Fourier methods are preferred rather than the correlation-like methods. The phase correlation method is based on the Fourier Shift Theorem [25] and was originally proposed for the registration of translated images. It computes the cross-power spectrum of the sensed and reference images and looks for the location of the peak in its inverse.

$$\frac{\mathscr{F}(f)\mathscr{F}(g)^*}{|\mathscr{F}(f)\mathscr{F}(g)^*|} = e^{2\pi i(ux_0 + vy_0)}$$

The method shows strong robustness against the correlated and frequency dependent noise and non-uniform, time varying illumination disturbances. The computational time savings are more significant if the images, which are to be registered, are large.

4.1.3. *Mutual information methods*
The mutual information (MI) methods are the last group of the area-based methods to be reviewed here. They have appeared recently and represent the leading technique in multimodal registration. Registration of multimodal images is the difficult task, but often necessary to solve, especially in medical imaging. The comparison of anatomical and functional images of the patient's body can lead to a diagnosis, which would be impossible to gain otherwise.
The MI, originating from the information theory, is a measure of statistical dependency between two data sets and it is particularly suitable for registration of images from different modalities. MI between two random variables X and Y is given by

$$\mathrm{MI}(X, Y) = H(Y) - H(Y|X) = H(X) + H(Y) - H(X, Y),$$

Where $H(X) = -E_v(\log(P(X)))$ represents entropy of random variable and PðXÞ is the probability distribution of X. The method is based on the maximization of MI (Fig. 2) Often the speed up of the registration is implemented, exploiting the coarse-to-fine resolution strategy (the pyramidal approach).
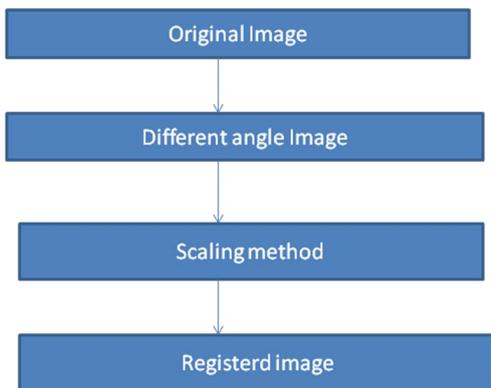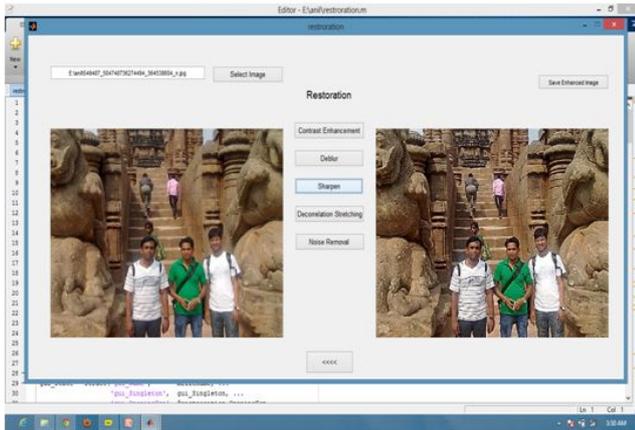
## RESTORATION (SHARPEN)





*Fig. 2. Mutual information: MI criterion (bottom row) computed in the neighborhood of point P between new and old photographs of the mosaic (top row). Maximum of MI shows the correct matching position (point A). Point B indicates the false matching position selected previously by the human operator. The mistake was caused by poor image quality and by complex nature of the image degradations.*

### 4.1.4. Optimization methods

Finding the minimum of dissimilarity measure (penalty function) or the maximum of similarity measure is a multidimensional optimization problem, where the number of dimensions corresponds to the degrees of freedom of the expected geometrical transformation. The only method yielding global extreme solution is an exhaustive search over the entire image. Although it is computationally demanding, it is often used if only translations are to be estimated.

### 4.2. Feature-based methods

We assume that two sets of features in the reference and sensed images represented by the CPs (points themselves, end points or centers of line features, centers of gravity of regions, etc.) have been detected. The aim is to find the pairwise correspondence between them using their spatial relations or various descriptors of features.

### 4.2.1. Methods using spatial relations

Methods based primarily on the spatial relations among the features are usually applied if detected features are ambiguous or if their neighborhoods are locally distorted. The information about the distance between the CPs and about their spatial distribution is exploited.

Goshtasby in Ref. [28] described the registration based on the graph matching algorithm. He was evaluating the number of features in the sensed image that, after the particular transformation, fall within a given range next to the features in the reference image. The transformation parameters with the highest score were then set as a valid estimate.

### 4.2.2. Methods using invariant descriptors

As an alternative to the methods exploiting the spatial relations, the correspondence of features can be estimated using their description, preferably invariant to the expected image deformation (see Fig. 3).

## REGISTRATION IN COLOUR IMAGE
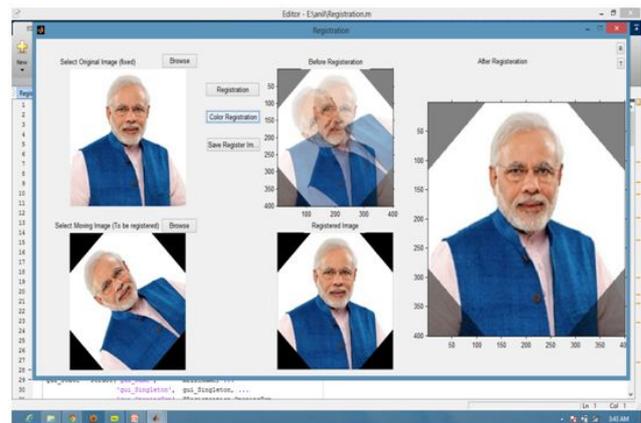


## RESTORATION (CONTRAST ENHANCEMENT)



*Fig. 3. Feature-based method using invariant descriptors: in these two satellite images, control points (corners) were matched using invariants based on complex moments [56]. The numbers identify corresponding CP's. The bottom image shows the registration result.*

The description should fulfill several conditions. The most important ones are invariance (the descriptions of the corresponding features from the reference and sensed image have to be the same), uniqueness (two different features should have different descriptions), stability (the description of a feature which is slightly deformed in an unknown manner should be close to the description of the original feature), and independence (if the feature description is a vector, its elements should be functionally independent).

However, usually not all these conditions have to (or can) be satisfied simultaneously and it is necessary to find an appropriate trade-off.

## V. TRANSFORM MODEL ESTIMATION

After the feature correspondence has been established the mapping function is constructed. It should transform the sensed image to overlay it over the reference one. The correspondence of the CPs from the sensed and reference images together with the fact that the corresponding CP pairs should be as close as possible after the sensed image transformation are employed in the mapping function design.

The task to be solved consists of choosing the type of the mapping function (see Fig. 4) and its parameter estimation. The type of the mapping function should correspond to the assumed geometric deformation of the sensed image, to the method of image acquisition (e.g. scanner dependent distortions and errors) and to the required accuracy of the registration (the analysis of error for rigid-body point-based registration was introduced in Ref. [26]).



*Fig. 4. Examples of various mapping functions: similarity transform (top left), affine transform (top right), perspective projection (bottom left), and elastic transform (bottom right).*

From another point of view, mapping functions can be categorized according to the accuracy of overlaying of the CPs used for computation of the parameters. Interpolating functions map the sensed image CPs on the reference image CPs exactly, whereas approximating functions try to find the best trade-off between the accuracy of the final mapping and other requirements imposed on the character of the mapping function. Since the CP coordinates are usually supposed not to be precise, the approximation model is more common.

### 5.1. Global mapping models
One of the most frequently used global models uses bivariate polynomials of low degrees. Similarity transform is the simplest model—it consists of rotation, translation and scaling only

$$u = s(x\cos(\varphi) - y\sin(\varphi)) + t_x$$
$$v = s(x\sin(\varphi) + y\cos(\varphi)) + t_y$$

This model is often called 'shape-preserving mapping' because it preserves angles and curvatures and is unambiguously determined by two CPs.

Slightly more general but still linear model is an affine transform

$$u = a_0 + a_1 x + a_2 y$$
$$v = b_0 + b_1 x + b_2 y,$$

Which can map a parallelogram onto a square. This model is defined by three non-collinear CPs, preserves straight lines and straight line parallelism.

### 5.2. Local mapping models
However, a global polynomial mapping cannot properly handle images deformed locally. This happens, for instance, in medical imaging and in airborne imaging. The least square technique averages out the local geometric distortion equally over the entire image which is not desirable. Local areas of the image should be registered with the available information about the local geometric distortion in mind. Like by using radial basis function:

$$u = a_0 + a_1 x + a_2 y + \sum_{i=1}^{N} c_i g(\mathbf{x}, \mathbf{x}_i)$$

Radial basis functions are representatives of the group of global mapping methods but they are able to handle even locally varying geometric distortions. The resulting mapping function has a form of a linear combination of translated radially symmetric function plus a low-degree polynomial and similarly for v.

## VI. IMAGE RESAMPLING AND TRANSFORMATION

The mapping functions constructed during the previous step are used to transform the sensed image and thus to register the images. The transformation can be realized in a forward or backward manner. Each pixel from the sensed image can be directly transformed using the estimated mapping functions. This approach, called a forward method, is complicated to implement, as it can produce holes and/or overlaps in the output image (due to the discretization and rounding). Hence, the backward approach is usually chosen. The registered image data from the sensed image are determined using the coordinates of the target pixel (the same coordinate system as of the reference image) and the inverse of the estimated mapping function. The image interpolation takes place in the sensed image on the regular grid. In this way neither holes nor overlaps can occur in the output image.

The interpolation itself is usually realized via convolution of the image with an interpolation kernel. An optimal interpolant—2D sinc function—is hard to implement in practice because of its infinite extent. Thus, many simpler

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interpolants of bounded support have been investigated in the literature.

The nearest neighbor function, the bilinear and bicubic functions (see Fig. 5), quadratic splines [13], cubic B-splines [15], higher-order B-splines [16], Catmull–Rom cardinal splines [17], Gaussians [22], and truncated sinc functions [25] belong to the most commonly used interpolants.
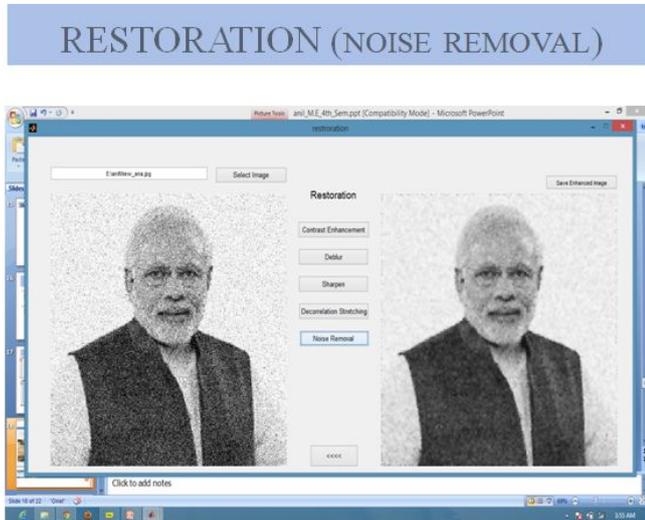


*Fig. 5. Image interpolation methods: the original image (top left) was enlarged five times using three different interpolation techniques—nearest neighbor (top right), bilinear (bottom left), and bicubic (bottom right).*

Even though the bilinear interpolation is outperformed by higher-order methods in terms of accuracy and visual appearance of the transformed image, it offers probably the best trade-off between accuracy and computational complexity and thus it is the most commonly used approach. Cubic interpolation is recommended when the geometric transformation involves a significant enlargement of the sensed image. Nearest neighbor interpolation should be voided in most cases because of artifacts in the resampled image. The only exclusion is when the image to be transformed contains low number of intensities and we do not want to introduce 'synthetic' graylevels/colors by higher order interpolation.

## VII. CONCLUSION AND OUTLOOK FOR THE FUTURE

Image registration is one of the most important tasks when integrating and analyzing information from various sources. It is a key stage in image fusion, change detection, super-resolution imaging, and in building image information systems, among others. This paper gives a survey of the classical and up-to-date registration methods, classifying them according to their nature.
When registering images with non-linear, locally dependent geometric distortions, we are faced with two basic problems—how to match the CPs and what mapping functions to use for registration. While the second one can be solved at least on theoretical level by using appropriate radial

basis functions, the first problem is generally unsolvable due to its nature. Since the between-image deformations can be arbitrary, we cannot use any automatic matching method. Another conceptual question here is how can we distinguish between image deformations and real changes of the scene.

In multimodal registration, MI technique has become a standard reference, mainly in medical imaging. However, being an area-based technique, the MI has principal limitations.
In the future, the idea of an ultimate registration method, able to recognize the type of given task and to decide by itself about the most appropriate solution, can motivate the development of expert systems. They will be based on the combination of various approaches, looking for consensus of particular results.

## REFERENCES

[1]S. Manjusha Deshmukh, A survey on image registration on International Journal of Image Processing (IJIP), Volume (5) : Issue (3) , 2011
[2] Barbara Zitova, Jan Flusser, Image registration methods: a survey on 2003 Elsevier B.V..
[3]S. Abdelsayed, D. Ionescu, D. Goodenough, Matching and registration method for remote sensing images, Proceedings of the International Geoscience and Remote Sensing Symposium IGARSS'95, Florence, Italy, 1995, pp. 1029–1031.
[4]H.S. Alhichri, M. Kamel, Virtual circles: a new set of features for fast image registration, Pattern Recognition Letters 24 (2003) 1181–1190.
[5]W.S.I. Ali, F.S. Cohen, Registering coronal histological 2-D sections of a rat brain with coronal sections of a 3-D brain atlas using geometric curve invariants and B-spline representation, IEEE Transactions on Medical Imaging 17 (1998) 957–966.
[6]R.J. Althof, M.G.J. Wind, J.T. Dobbins, A rapid and automatic image registration algorithm with subpixel accuracy, IEEE Transactions on Medical Imaging 16 (1997) 308–316.
[7]P.R. Andersen, M. Nielsen, Non-rigid registration by geometry-constrained diffusion, Medical Image Analysis 5 (2001) 81–88.
[8]P.E. Anuta, Spatial registration of multispectral and multitemporal digital imagery using Fast Fourier Transform, IEEE Transactions on Geoscience Electronics 8 (1970) 353–368.
[9]C.R. Appledorn, A new approach to the interpolation of sampled data, IEEE Transactions on Medical Imaging 15 (1996) 369–376.
[10]N. Arad, N. Dyn, D. Reisfeld, Y. Yeshurun, Image warping by radial basis functions: application to facial expressions, CVGIP: Graphical Models and Image Processing 56 (1994) 161–172.
[11]M.A. Audette, F.P. Ferrie, T.M. Peters, An algorithmic overview of surface registration techniques for medical imaging, Medical image Analysis 4 (2000) 201–217.
[12]R. Bajcsy, S. Kovacic, Multiresolution elastic matching, Computer Vision, Graphics and Image Processing 46 (1989) 1–21.
[13]S. Banerjee, D.P. Mukherjee, D.D. Majumdar, Point landmarks for registration of CT and NMR images, Pattern Recognition Letters 16 (1995) 1033–1042.

[14]D.I. Barnea, H.F. Silverman, A class of algorithms for fast digital image registration, IEEE Transactions on Computing 21 (1972) 179–186.

[15]I. Barrodale, D. Skea, M. Berkley, R. Kuwahara, R. Poeckert, Warping digital images using thin plate splines, Pattern Recognition 26 (1993) 375–376.

[16]H.G. Barrow, J.M. Tenenbaum, R.C. Bolles, H.C. Wolf., Parametric correspondence and chamfer matching: Two new techniques for image matching. Proceedings of the Fifth International Joint Conference on Artificial Intelligence, Cambridge, Massachusetts, 1977, pp. 659–663.

[17]R.K. Beatson, G.N. Newsam, Fast evaluation of radial basis functions, Computers Mathematical Applications 24 (1992) 7–19.

[18]Y. Bentoutou, N. Taleb, M. Chikr El Mezouar, M. Taleb, J. Jetto, An invariant approach for image registration in digital subtraction angiography, Pattern Recognition 35 (2002) 2853–2865.

[19]R. Berthilsson, Affine correlation. Proceedings of the International Conference on Pattern Recognition ICPR'98, Brisbane, Australia, 1998, p. 1458–1461.

[20]P.J. Besl, N.D. McKay, A method for registration of 3D shapes, IEEE Transactions on Pattern Analysis and Machine Intellinegce 14 (1992) 239–254.

[21]S.S. Beuchemin, J.L. Barron, The computation of optical flow, ACM Computing Surveys 27 (1995) 433–467.

[22]D. Bhattacharya, S. Sinha, Invariance of stereo images via theory of complex moments, Pattern Recognition 30 (1997) 1373–1386.

[23]F.L. Bookstein, Principal warps: Thin-plate splines and the decomposition of deformations, IEEE Transactions on Pattern Analysis and Machine Intelligence 11 (1989) 567–585.

[24]G. Borgefors, Hierarchical chamfer matching: a parametric edge matching algorithm, IEEE Transactions on Pattern Analysis and Machine Intelligence 10 (1988) 849–865.

[25]R.N. Bracewell, The Fourier Transform and Its Applications, McGraw-Hill, New York, 1965.

[26]P.A. Brivio, A.D. Ventura, A. Rampini, R. Schettini, Automatic selection of control points from shadow structures, International Journal of Remote Sensing 13 (1992) 1853–1860.

[27]M. Bro-Nielsen, C. Gramkow, Fast fluid registration of medical images, In Proceedings Visualization in Biomedical Computing (VBC'96), 1131, Springer Lecture Notes in Computer Science, Hamburg, Germany, 1996, pp. 267–276.

[28]L.G. Brown, A survey of image registration techniques, ACM Computing Surveys 24 (1992) 326–376.

[29]S.C. Cain, M.M. Hayat, E.E. Armstrong, Projection-based image registration in the presence of fixed-pattern noise, IEEE Transactions on Image Processing 10 (2001) 1860–1872.

[30]J. Canny, A computational approach to edge detection, IEEE Transactions on Pattern Analysis and Machine Intelligence 8 (1986) 679–698.

[31]E.D. Castro, C. Morandi, Registration of translated and rotated images using finite Fourier transform, IEEE Transactions on Pattern Analysis and Machine Intelligence 9 (1987) 700–703.

[32]S.H. Chang, F.H. Cheng, W.H. Hsu, G.Z. Wu, Fast algorithm for point pattern matching: Invariant to translations, rotations and scale changes, Pattern Recognition 30 (1997) 311–320.

[33]Q. Chen, M. Defrise, F. Deconinck, Symmetric phase-only matched filtering of Fourier–Mellin transform for image registration and recognition, IEEE Transactions on Pattern Analysis and Machine Intellingence 16 (1994) 1156–1168.

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