Hybrid of feature finding technique for efficient Image Registration

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Abstract : Image registration has vital application in sensor images, medical images etc. Basic task of image registration is to fit or align two images on each other in order to make one meaningful image. Feature finding is one of the foremost and most important step in image registration. Many methods has been proposed.Every method has their own features and limitations. In the current paper we are going to hybrid Zernike and ACO method for optimzed feature point estimation.The hybrid has been applied on non-rigid images and is checked for different quality metrics.

KEYWORD: Ant colony optimization(ACO), Zernike moment, RANSAC.

I.INTRODUCTION

Image registration is one of the crucial step in task of image analysis. It is also referred as super-imposition or matching. Basically , image registration is the determination of geometrical transformation, in order to align the points of source image with the corresponding points in target image. These images could be taken from different sources at different point of time[1].

In general, there are two types of Image registration techniques[2,3,4]: area-based and feature-based methods. Area-based methods calculate the transformation among source image and target image by analyzing pixel intensities of an image using properties such as mutual information, fourier transforms etc.. On the other hand, feature based techniques find correspondence between image features .They should be distinct spread all over the image and efficiently detectable. They are likely to be stable in time to stay at fixed positions during the whole experiment. It establish a correspondence between a number of distinct points in images. After finding correspondence, a transformation is then determined to map the target image to the reference images, in order to form a point-by-point correspondence between the reference and target images[5].

Basically there are two types of transformation that is Rigid and Non-Rigid[6,7]. In general, any proper rigid transformation can be decomposed as a rotation followed by a translation. Any object will keep the same shape and size after a proper rigid transformation, but not after an improper one.All rigid transformations are affine transformations. Used for within-subject registration when there is no distortion e.g. MR to SPECT/PET Registration.On the other hand,a non-rigid transformation is a mathematical phenomenon in which the shape of the curve is altered after a transformation has been done. The two main types of non-rigid transformations are stretch and shrink. It is required for inter-subject registration and distortion correction. It is Non-linear.

An interesting feature based technique was recently developed[2] which was based onscale interactions of Mexican-hat wavelets for feature point extraction[13,14], then descriptor vectors were obtained by computing the Zernike moments on each feature point[2]. After, then the correspondence among feature points were calculated by comparing the descriptor vectors. Further the transformation parameters were estimated[16] and finally image was registered.This registration technique worked well for images with partial overlap, images with different scales, and degradations like noise contamination etc. whichmake this registration technique a good candidate for use in applications such as aerial image registration, face image recognition and image mosaicking[2].Butthe technique was not applied to non-rigid images, as these images are complex and contains noise, so Zernike alone will not be sufficient to register such images because it has a limitation that changing the resolution does not preserve moments and, resistance to noise is very poor. As well as the registration will become slow and error rate will also increase and quality will degrade.So in order to make this technique applicable on complex images we need to combine Zernike with some other method.Most suitable method will be ant colony optimization, which is related to finding good paths through graphs. As it works as a global optimization method to obtain good initial values . This method is based on real ant behavior and it works well for solving different optimization problems such as vehicle routing problem .This method is effective, accurate and fast as compare to local methods[8,10].

So, we have Hybrid the properties of ant colony optimization(ACO) with the zernike moment in order to overcome the limitations of Zernike and making this technique suitable for finding optimal feature points for non-rigid images.

The paper is organized as follows. In section 2 the proposed algorithm that is hybrid of ANTzernike algorithm is demonstrated. In section 3 the implementation results are presented. In section 4,finally the conclusion and future work of this paper is presented.

II PROPOSED ALGORITHM

The proposed algorithm is the hybrid of ACO and Zernike. The hybrid is basically done to have a good feature point estimation method , which is one of the crucial task in image processing. The proposed algorithm consist of seven steps and is as follows:

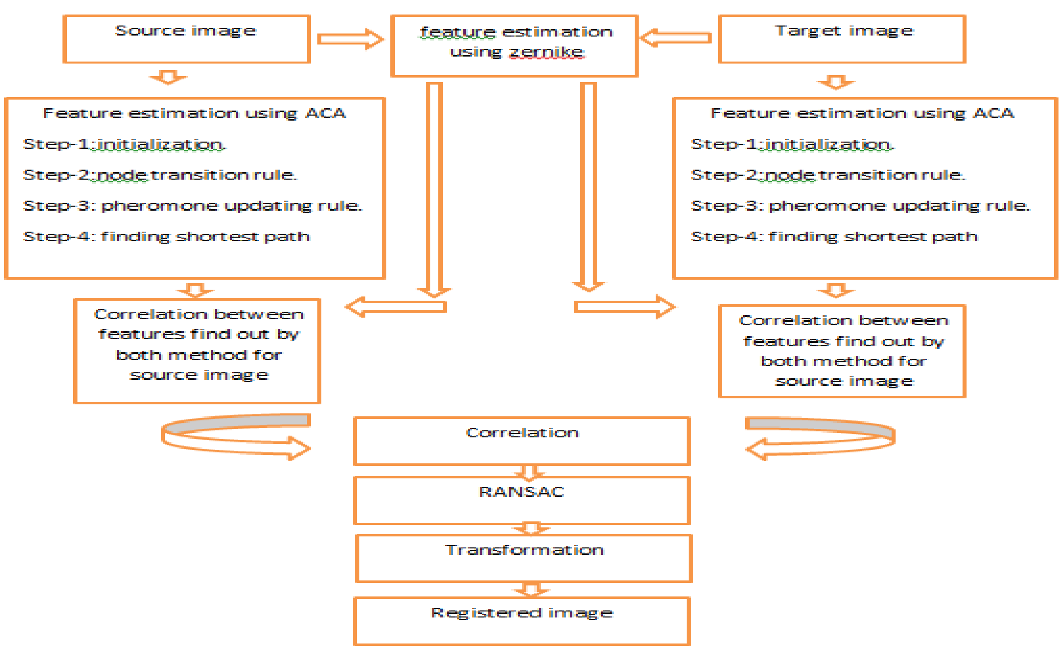


Fig 1: Complete working of proposed algorithm which is hybrid of ANTzernike

STEP-1 Feature point estimation using Zernike: Firstly the source image is passed on to the zernike moment, where feature points are extracted . it results in two sets of feature points, i.e P_s for source image and P_s' target image. Then for each feature point the descriptor vectors are calculated and descriptor vectors are obtained by computing the Zernike moments of circular neighbourhoods centered on each feature points as done in[9].

STEP-2 Feature point estimation using ACO: Again the same original source image is passed to ACO for feature point estimation.The ant colony optimization Technique is used for solving problems that are related to finding good paths through graphs[15].

The behavior of each ant in nature[10]:

- Wander randomly at first, laying down a pheromone trail
- If food is found, return to the nest laying down a pheromone trail
- If pheromone is found, with some increased probability follow the pheromone trail
- Once back at the nest, go out again in search of food

However, pheromones evaporate over time, such that unless they are reinforced by more ants, the pheromones will disappear.

ACA method is based above real ant behavior include following three principles10[]:

(i).*Initialiaztion:*The initialization includes two parts:the representation of graph problem and initial distribution of ant.First the problem is represented in the form of graph, G=$< N, E >$, N is the set of nodes and E is set of edges.Secondly , the number of ants are placed on randomly choosen nodes. Further each ant will perform a tour on graph and constructs a path according to node transition rule.

(ii)*node transition rule:*ants move from node to node according to the rule. As per problem –domain conditions, some nodes could be marked as inaccessible for an ant that is walking. the rule is probabilistic.For k-th ant that is on node I, the next node j is selected according to transition rule:

$$p_{ij}{}^{k} = \begin{cases} \dfrac{(\tau_{ij})^{\alpha}(\eta_{ij})^{\beta}}{\sum_{h \in \text{tabu}_k} (\tau_{ih})^{\alpha}(\eta_{ih})^{\beta}} & \text{if } j \notin \text{tabu}_k \\ 0 & otherwise \end{cases}$$ [10]

τ_{ij} it is the attractiveness that is laid on edge(i,j). n_{ij} is visibility of edge. α and β are control parametres.$Tabu_k$ is set of inaccessible nodes for k-th ant.

(iii).*Pheromone updating rule:* Ants keep on applying the node transition rule while walking through edges till it constructs a solution to the problem. By the end of the cycle, the attractiveness of pheromone trail is updating using pheromone updating rule:

$$\tau_{ij} = \rho \tau_{ij} + \sum_{k=1}^{m} \Delta \tau_{ij}{}^{k}$$ [10]

$\rho \epsilon (0,1)$ is persistence rate , $\Delta \tau_{ij}{}^{k}$ it is the amount of pheromone that is laid on edge and m is number of distributed ants.In the real ant system, the paths which are shorter have more quantity of pheromone.If we say L_k as the total lenth of ant k in a cycle,as a value of fitness to solution, then $\Delta \tau_{ij}{}^{k}$ is given by:

$$\Delta \tau_{ij}^{k} = \begin{cases} \frac{Q}{L_k} & \text{if edge } (i, j) \text{ is traversed by the } k\text{-th ant at this cycle} \\ 0 & \text{otherwise} \end{cases}$$ [10]

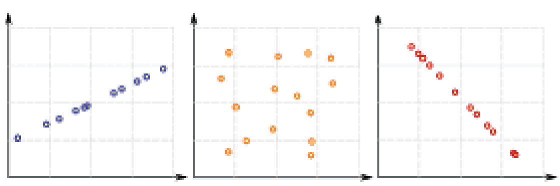
Q is constant and pheromone laid is perverselyProportional to length.

STEP-3: Correlation: In this step the correlation is find among the features that are independently findby Zernike and ACO for source image.
Correlation defines the accurate measurements of changes in images and also signifies how strongly are images linked.basically it is a degree to which to which two or moe quantities are linearly associated.
Correlation coefficient is given by:

$$r_{xy} = \frac{\sum_{i=1}^{n}(x_i - \bar{x})(y_i - \bar{y})}{\sqrt{\sum_{i=1}^{n}(x_i - \bar{x})^2 \sum_{i=1}^{n}(y_i - \bar{y})^2}}$$ [17,18]

Correlation coefficient r can be used in image processing, security applications or in pattern recognition.

- If r = 1, it means that the two images are absolutely identical.
- If r = 0, it means that two images are completely uncorrelated.
- If r = -1, it means the two images are completely anti-correlated[18].



r = 1   r = 0   r = -1

Perfect Positive Correlation   No Correlation   Perfect Negative Correlation

Step-4: Now the, same process that is from step- to 3 is applied on target image. In which feature points are calculated and correlated for target image.

Step-5: Correlation between source image and target image: in this the correlation or say similarity between the feature point is found between source image and target image. Same computation is done as in step-3.

Step-6: RANSAC: RANSAC is applied after the completion of previous step i.e correlation. RANdom SAmple Consensus is applied to check the validity of points.The assumption that is considered is that data consist of inliers

and outliers. Outlier is the data which donot fit in the model and they come due to large value of noise or incorrect hypothesis.It also assumes that for a given set of inliers, there is a procedure which estimates the parametres of model or which fits this data .
Algorithm is as follows:

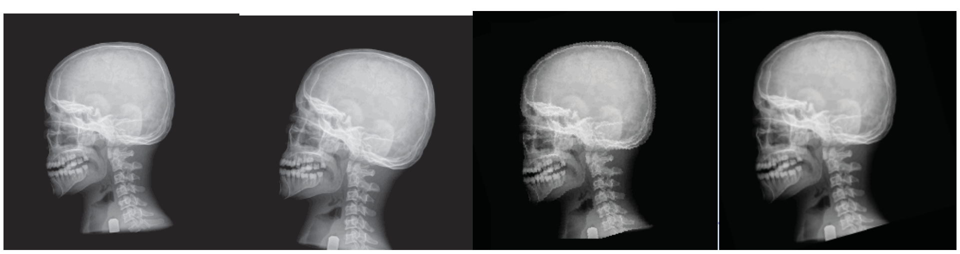
(i) first find out those points, that will use to help to construct some actual relation between two entities.
(ii) Its parameters are find out and we fit its tolerance with nrespect to other entity.
(iii) Then, we re-estimate parameters and calculate the threshold.
(iv) If points exceed thresholding, then identified inliers are terminated.
(v) Repeat this process , till all points are estimated.

Step-7: finally the transformation parametres are estimated, which is basically performed to transform the image that is distorted to its suitable size, position and preference using a weighted least square technique as computed in[20]and finally image is registered.

IV IMPLEMENTATION RESULTS

In this section we evaluate the effectiveness of proposed technidue that is registration using ANTzernike. Firstly the parameter of structural content(SC)calculates the similarity between two images.Secondly, the average difference(AVD) is calculated which signifies that how much error has been added during reconstruction, so to give the difference between two images. Third parameter that is normalized absolute error(NAE) indicates absolute error difference between pixels.

Example 1: (a) source image (b) target image (c)registered image using ANTzernike (d) registered image using ZERNIKE alone

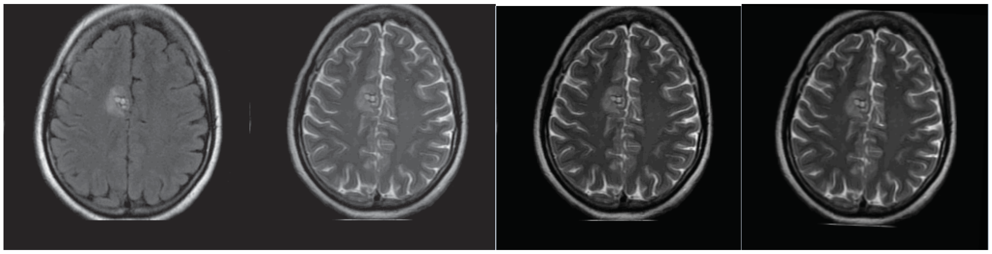


(a) (b) (c) (d)

Example 2: (a) source image (b) target image (c)registered image using ANTzernike (d) registered image using ZERNIKE alone

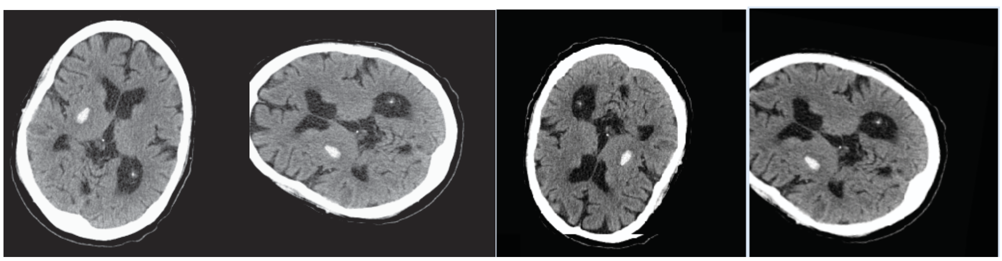
(a) (b)(c) (d)

Example 3: (a) source image (b) target image (c)registered image using ANTzernike (d) registered image using ZERNIKE alone



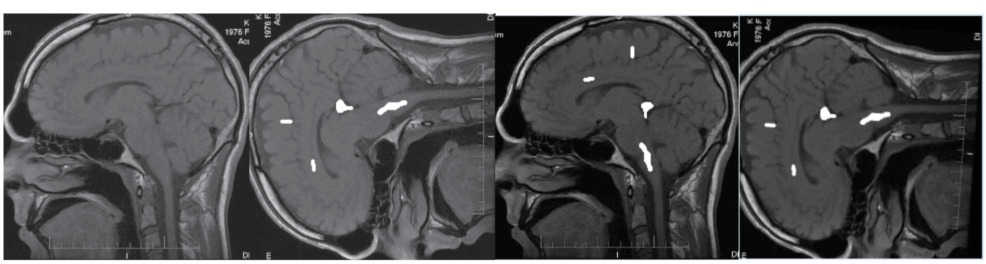
(a) (b)(c) (d)

Example 4: (a) source image (b) target image (c)registered image using ANTzernike (d) registered image using ZERNIKE alone



(a)(b)(c) (d)

Example 5: (a) source image (b) target image (c)registered image using ANTzernike (d) registered image using ZERNIKE alone



(a) (b)(c) (d)

Table 1.1:Image registration using proposed technique i.e using ANTzernike for registration:

Image set	SC	AVD	NAE
Example 1	2.4	50.6591	0.998
Example 2	4.5	50.5	0.999
Example 3	8.2	38.5	0.990
Example 4	6.02	68.3	0.9997
Example 5	1.3	53.6	0.9994

Table 1.2: Image registration using Zernike:

Image set	SC	AVD	NAE
Example 1	0.3	93.6	1.8398
Example 2	0.1585	87.54	1.7477
Example 3	0.18	88.3	2.359
Example 4	0.4	76.04	1.3588
Example 5	0.1962	88.3	1.6743

The results shows that, by using the proposed technique i.e combination of ANTzernike for image registration is better as compare to registration with alone Zernike. Because by using the proposed technique the similarity factor among source and target image has improved as well as average difference and error rate is minimized.

V CONCLUSION AND FUTURE WORK

Hybrid of ACO and Zernike has been presented. Combining the features of ACO with Zernike improves the quality, similarity in registering images and also decreases the error difference between pixels. As well as , making the technique reliable and efficient for finding complex features for registration of imagesas well as makes this technique robust and fast as compare to earlier method i.e using Zernike..

In future we may work for combination of other feature extraction methods such harris corner detection method, susan feature point finding or mosaicking techniques for feature finding and result will be verified accordingly, and more quality parameters need to be verified .

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