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Image Registration Using MAC RANSAC

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Abstract: ***Image registration is a process of registering one image into another image. This process is quite common in the medical terms and history. A correct registration is said to be done if the registered image possess a good and also if the registration method supports scalability and transformation. A lot of previous methods have been already opted in this contrast. This paper focuses on different aspects of image registration and the image registration process using MAC-RANSAC technique. This paper also focuses on the change of the results of the image if the image is scaled or rotated to some extent to enhance the robustness of the image registration process.***

Keywords: Image registration, MAC RANSAC, Robustness

1. Introduction

Image registration is the process of mapping points in one image to the corresponding points in an another image. It has many applications in biomedical images such as building statistical anatomical atlas, building image retrieval and indexing applications. The goal of research paper is performing an image registration to deform an ultrasound image to match a model image for the purpose of building statistical atlases. Because the shapes of the prostates of different people vary quite significantly, affine transformations (e.g. scaling, shearing, rotation, and translation) and small-deformation methods (e.g. thin-plate splines and linear-elastic models) are not sufficient for such image registration. Furthermore, the large variance in intensity and the presence of speckles noise in ultrasound images do not allow intensity-based image registration to perform reliably. Image Registration refers to a class of methods that aim to remove or reduce the degradations [2] and registers the points of second image into the base image. That has occurred while the digital image was being obtained.

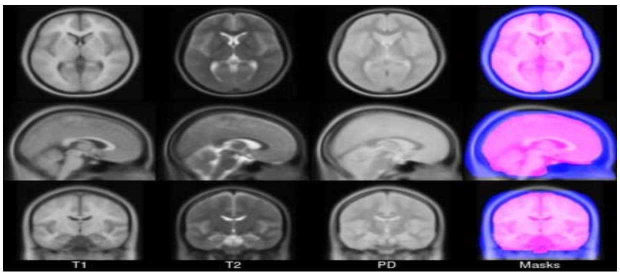

Figure 1: Represents the entire registration steps

All natural images when displayed have gone through some sort of degradation. The purpose of image registration is to "compensate for" or "undo" defects which degrade an image or to make compatibility between the two images. The degradation in an image comes in many forms such as motion; blur, noise, and camera miss focus. In motion blur, it is possible to come up with a very good estimate of the actual blurring function and "undo" the blur to restore the original image [1]. When the image gets corrupted by noise, we may hope to compensate for the degradation it had caused. In our approach to register an image into another image we have used neural network as the basis classifier which identifies the points where the image to be registered and contour distance classifier which is used to classify the distance vectors of the image.

2. Related Work

The Pixel based methods use cross correlation as the similarity measure. It shows match at multiple points in natural images like buildings. Feature based methods use features like edges, points of intersection for registration. This method is time consuming and manual. This method has the advantage of filtering out the redundant information [3]. For feature based images features must be detected and then matched. For feature based images method of point mapping has been used in which features are computed and the control points in the reference image are matched with the feature points in data image and then spatial mapping is performed. In this there is a probability that there is a mismatch between the images.[4] Contour based image registration uses high statistical features for matching of image feature points. The registration process using this method is slow and manual.

3. Steps for Image Registration

Registration is a fundamental task in image processing used to match two or more pictures which have been taken at different times, from the different sensors, or from the different viewpoints. All large systems which evaluate images require the registration of images. The examples of systems where image registration has significant component include matching a target image with a real-time image of a scene for the purpose of target recognition, for monitoring global land usage using the satellite images, matching of stereo images for recovery of shape in autonomous navigation, and aligning of images from different medical modalities for diagnosis. Over the years, a broad range of techniques has been developed for various types of data. The techniques have been studied for several different applications, resulting in a large body of research. The paper organizes the material by establishing the relationship between the variations in the images and the type of registration techniques which can most appropriately be applied. Three major types of variations are distinguished. The first type is the variations due to the differences in acquisition which makes the image misaligned. To register an image, spatial transformation is the solution which removes these variations. This class of transformations must be able to find the optimal transformation determined by knowledge. The transformation class in turn influences the general technique that should be taken. The second type of variations is those which are also due to differences in acquisition, but cannot be modeled easily which may include lighting and atmospheric conditions. This type usually affects intensity values. The third type of variations is difference in images that are of interest such as object movement, growth, or other scene changes. Variations of second and third type cannot be directly removed by registration. These make registration more difficult since an exact match is no longer possible. Variations of the third type are not removed. The Knowledge about the characteristics of each type of variation effect the choice of the feature space, the similarity measure, the search space, and search strategy which will make up the final technique. All registration techniques can be viewed as different combinations of these choices. The framework is useful for understanding the merits and relationships between the wide variety of existing techniques and for assisting in the selection of the most suitable technique for a specific problem.

Image registration process can be understood with the following figure. In any image registration process there are two images namely source and the target image. After the completion of the preprocessing steps that includes the noise removal and other related terms similarity matrix is searched so that the image can be registered. If the similarity matrix is found good enough for the convergence the registration process is complete else the procedure is repeated.

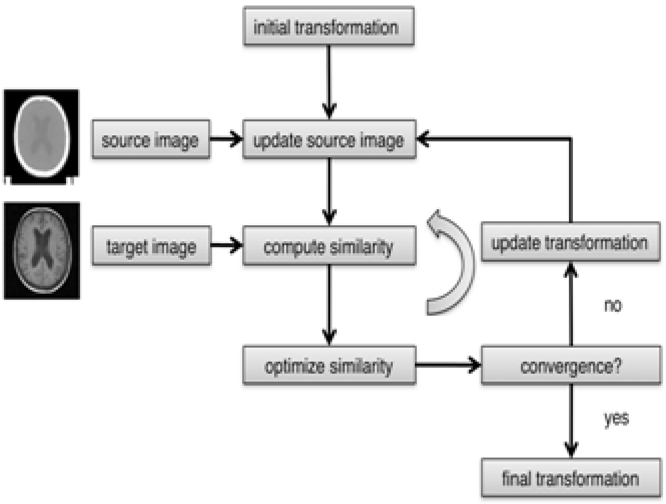

Figure 2: Representing the image registration process

4. Image Registration Algorithm

4.1 RANSAC and MAC RANSAC

RANSAC is an abbreviation for "Random Sample Consensus". This is an iterative method for estimating parameters of a mathematical model obtained from a set of observed data which contain outliers. It is a non-deterministic algorithm in the sense that it produces a reasonable result only with a certain probability, with this probability increasing as more iteration are allowed. The algorithm was first published by Fischer and Boles at SRI International in 1981.

The RANSAC algorithm [1] is an algorithm for robust fitting of models in the presence of many data outliers. This algorithm is very simple. Given a fitting problem with parameters $\vec{x}$, estimate the parameters.

Assume:
1. The parameters can be estimated from *N* data items.
2. There are *M* data items in total.
3. The probability of a randomly selected data item being part of a good model is p_g.
4. The probability that the algorithm will exit without finding a good fit if one exists is p_{fail}.

Then, the algorithm:
1. selects N data items at random
2. estimates parameter $\vec{x}$
3. Finds how many data items (of *M*) fit the model with parameter vector $\vec{x}$ within a user given tolerance. Call this *K*.
4. If *K* is big enough, accept fit and exit with success.
5. repeat 1..4 *L* times
6. fail if you get here

4.2 MAC RANSAC

MAC RANSAC has an edge over the RANSAC algorithm. The RANSAC algorithm is applied for the single detection of the objects where as the MAC RANSAC can be used for the multiple object detection in the same region. This procedure saves a lot of time in comprehensive image registration methods.

Feature Extraction Method – SIFT

SIFT stands for scale invariant feature transform. This particular algorithm is used when one need to generate features (minute) from a selected region. The main aspects of SIFT are;

a) Key Point Localization
b) Invariant Detection
c) Region Selection

4.3 Neural Networks

Neural networks, with their remarkable ability to derive meaning from complicated or imprecise data which can be used for extracting patterns and detecting trends that are too complex to be noticed by either humans or the other computer techniques. The trained neural network can be thought to be an "expert" in case of information it has been given to analyze. This can then be used to provide the projections if new situations of interest are provided and answer "what if" questions.

Other advantages include:

1. Adaptive learning: An ability to learn how to do tasks based on the data given for training or initial experience.
2. Self-Organization: An ANN can create its own organization or representation of the information it receives during learning time.
3. Real Time Operation: ANN computations may be carried out in the parallel, and many special hardware devices are being designed and manufactured to take the advantage of this capability.
4. Fault Tolerance via Redundant Information Coding: Partial destruction of a network leads to the corresponding degradation of the performance of the network. Some network capabilities may be retained even with the major network damage.

4.4 Neural networks versus conventional computers

Neural networks take a different approach to problem solving than that of conventional computers. The conventional computers use an algorithmic approach which means the computer follows the set of instructions in order to solve a problem. The computer needs to follow some steps to solve a problem. This provides restriction to the problem solving capability of the conventional computers to problems that we already understand and know how to solve. The computers would be much more useful if they could do things that we don't exactly know how to do.

Neural networks process information in a similar way like the human brain. In this the network is composed of large number of interconnect processing elements known as neurons working in parallel to solve the specific problem. A neural network is basically learning by example. These cannot be programmed to perform the specific task. The dataset must be selected very carefully otherwise useful time is wasted or even network might be performing the functions incorrectly. The disadvantage is that because the network finds the solution of problem by itself, its operation may be unpredictable.

On the other hand, conventional computers use a cognitive approach to problem solving; the way the problem is to solved must be known and stated in small unambiguous instructions. The instructions are then converted to the high level language program and then converted into machine code that computer can understand. These are predictable in nature; if anything goes wrong that is due to software or hardware fault.

Neural networks and conventional algorithmic computers are not in competition but these complement each other. There are tasks that are more associated to an algorithmic approach like the arithmetic operations and tasks which are more suited to neural networks. A large number of tasks, requires the system that uses combination of both two approaches (normally a conventional computer is used to supervise the neural network) in order to perform at maximum efficiency.

5. Results and Conclusion

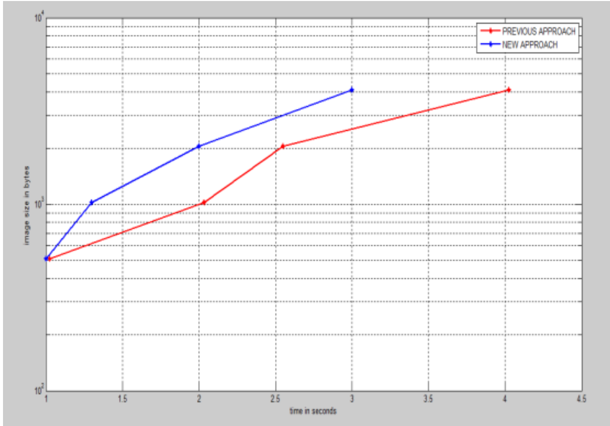

Figure 3: Graph for time taken for Registration

The above figure represents the time consumption of the registration process. As it can be clearly seen that the MAC RANSAC method takes less time for the registration of images than the time taken by RANSAC algorithm for registration.

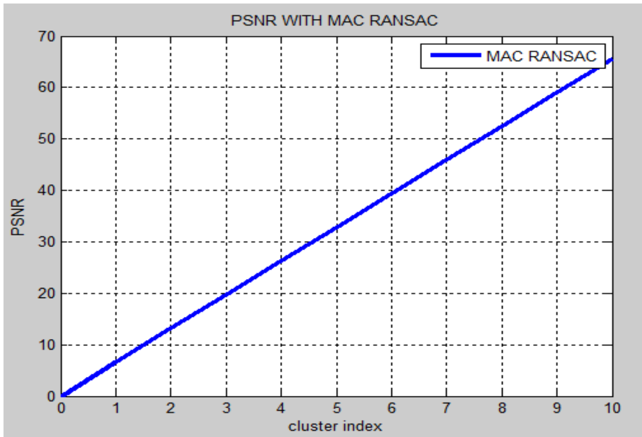

Figure 4: Graph for PSNR of MAC RANSAC

The above graph represents the peak signal to noise ratio in decibels for the proposed approach that is, MAC RANSAC approach.

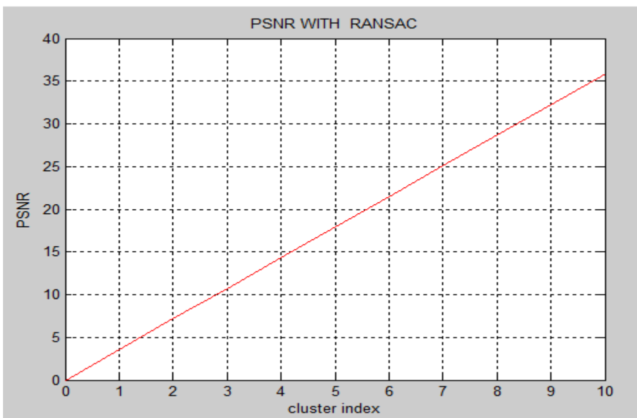

Figure 5: Graph for PSNR for RANSAC

The above graph represents the peak signal to noise ratio in decibels for the RANSAC approach. From the above two graphs it is clear that PSNR value for the proposed approach is more than the PSNR value of the previous approach. The large value of PSNR for the proposed approach signifies better registration of the images. The comparison of the results is tabulated as follows:

RANSAC MAC RANSAC

MSE	PSNR	MSE	PSNR
0.8748	36.58	0.0035	60.67
0.4808	50.65	0.3697	57.35
0.7930	38.62	0.3277	48.22
0.8992	38.63	0.3263	47.22
0.9588	46.99	0.2546	53.83

The above comparison shows that using the MAC RANSAC technique MSE has reduced significantly and PSNR has increased. The lower value of MSE shows better registration. Since the value of MSE for MAC RANSAC is lower than the value of MSE for RANSAC algorithm, it implies that the proposed algorithm has performed better registration than the existing algorithm.

With the above results, it is concluded that the MAC RANSAC is one of the better option for the image registration process as it selects multiple areas at one time. The current research work opens up a lot of possibilities for the future research workers as the current research does not test the versions of NEURAL network and its effect with the combination of MAC RANSAC.

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