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A Survey on interactive multi-label segmentation using cellular automata

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***Abstract*— Image segmentation is the process of partitioning a digital image into multiple segments. The goal of segmentation is to change the representation of an image into more meaningful and easier to analyze format. There are various interactive approaches to segment the area of interest from the given image. In this paper a survey on various image segmentation techniques has been performed and the methods are classified and compared as per the techniques used. The results of the segmentations are also compared both quantitatively and qualitatively. This survey provide a base for the future research in field of image segmentation.**

***Keywords*— cellular automata., image segmentation, interactive.**

I. INTRODUCTION

SEGMENTATION: The divisions of an image when categorised into regions resembling to the different parts of an object or various objects then it is known as image segmentation. The problem of localising regions from the image relative to the content is defined as the image segmentation [2]. It is a technique which separates or segregates an image into the parts which can also be known as segments [3]. Image segmentation is a technique in which the images are divided into the multiple parts or sub parts which are in the form of pixels [4]. The allocation of the pixel in an image is done to any one of these categories. The characteristics of a good pixel are as follows: the connected region is formed by the pixels if they fall under the same category having similar grey scale values of multivariate, the values of the pixels falling in different category like the neighbourhood pixels are dissimilar. There are different types of segmentations like Manual Segmentation which is done manually and is time consuming consisting of errors sometimes, then is the automated segmentation which involves the segmentation done semi-automatically but then they cannot be carried out autonomously and the third is the interactive segmentation is one in which a series of interactions are needed for the detections and the extractions of semantic objects sourcing through the manual operators with higher grade of information. There are 4 important characteristics which should be fulfilled by the interactive segmentation algorithm. They are: computation and the Editing should be speedy and fast, it should be capable of synthesizing a random or indiscriminate segmentations including sufficient interaction, and the segmentation should be institutive [1]. Three Approaches of image segmentation are threshold, edge and region based.

CELLULAR AUTOMATA: The cellular automata is the made up of a number of small and individual components called cells which are in the form of the spatially extended decentralised system. It is generally seen as a very simple model. There is a local interaction between the neighbouring or constituent cells to which the communication is limited (local). The presence of the individual cell is in a specific position and every cell is in a state which is specific, but these states changes with time according to the local neighbours as they depend upon each other. It exhibits the parallel processing device structure. The simple structure can be converted to a complex one if it undergoes iteration several times exhibiting the simulation potential regarding the different sophisticated natural phenomenon. Therefore, these are structures which are simple in nature but their behaviour is complex although their build is simple. The model of cellular automata uses very simple rules but is a very complex system. The problem space is divided by CA into a number of cells and these cells can be in one state or in various final states [5, 6]. A cellular automata is a lattice network of cells which shape is most commonly square, but the cells can be hexagonal and other shapes as well. The simplest case where each cell can exist in two possible states , can be denoted by the symbols 0 and 1 and graphically by white and black, respectively. In more anthropomorphic terms, we can think of cells in the 0 (white/quiescent) state as ‘dead’ and those in the 1 (black) state as ‘alive’. The states of lattice can be n dimentional but most of the work is done on one or two dimentions.each cell’s state changes as a function of time according to defined set of rules that includes the states of the neighboring cells.[7]

Two most common types of CA is one dimension and two dimension. The one-dimensional cellular automaton exists

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on an infinite horizontal array of cells. The shape of cells is square that are limited to only two possible states per cell: white and black. The two dimensional cellular automata if shape of cells is a rectangular or hexagonal.

LITERATURE REVIEW

DEFINATIONS:

Magic wand is the most common tool which is selected nowadays for most of the image editing. From the regions specified image point the colour statistics is gathered, the image region is then segmented with pixels the properties of the colour falls within gathered statistics tolerance.

Intelligent Paint it is a technique which is region based and includes the interactive segmentation, by the tobogganing the segmentation is based on the hierarchical image. The object region is defined by the collect and the connect strategy. Hierarchical tobogganing algorithm strategy is used to connect automatically to the regions of the image that flow together naturally and the interface expansion which is cost-ordered and cumulative along with it is user guided, it is used in the collection of those regions interactively which is the object of the interest. This is an interaction between the human and a computer which extracts the objects which are of the interest from the complex background using the strokes of the paint with the help of the mouse [8].

Intelligent Scissors it is a method which is boundary based and among the user specified boundary paths it computes the minimum cost. For the calculation of the boundary it uses the graph algorithm which is the shortest path along with this each and every pixel is treated as a graph mode. The image over segmentation is done using tobogganning as this is the faster version of region based intelligent scissors as the homogeneous regions are treated as the graph nodes [9].

Graph Cut is a technique which is used for the image segmentation. The whole image in this is treated as the graph and the pixels are treated as the graph nodes. By using the minimum cut algorithm the two labels i.e. object and the background can be efficiently computed together. There is an automatic labelling of the pixels if the user specified objects and the background seed pixels are given [9]

Grab Cut it is the extension of the graph cut method as it introduce the iteration segmentation then using the graph cut for the intermediate steps. In this the user gives the first approximation of the background labelling by drawing a rectangle around the object. Then according to the present segmentation the colour statistics are gathered after each iteration step then the image graph is re-weighted and then the new refined segmentation is computed. By specifying the seed which are similar to the graph cut the segmentation results are refined after the iteration is stopped [9].

Image Segmentation Techniques by Other Researchers

Among the techniques which are global boundary based the popular ones are dynamic programming and the graph searching which are based on the local cost and are used to find the global optimal boundaries. An optimal solution is found for the formulation of the boundary problems as accost functional or directed graph.

Ballard and Sklansky (1973) have reported the extended work of algorithm defined by Montanari. He used various techniques like gradient magnitude and the direction and their evaluation function in a closure measure. The circular tumours were detected by the directed dynamic programming search in the chest radiographs.

Cappalletti and Rosenfeld (1989) has reported the further use of the algorithm of Nilsson for the extraction of the boundaries which were closed and two dimensional present in each and every slice of the 3 dimensional volume by the help of the searching constraints. The main function of a three dimensional gradient is the local cost, and a contour from any of the neighbouring slice was bearing an extra distance cost. For the improvement of the boundary in each iterations the searching of the graphs was practically applied iteratively in both the dimensions which were 2D and 3D.

Prastawa et.al (2004) have reported the various measures of the performance for manual expert segmentations which were used in the literature as the ground truth, were false negative and positive volume fractions, dice overlap, Jaccard index etc. Among them for the comparisons of the

previous literature the most common method used was the dice overlap. He reported an average overlap of 3 patients within 1.5 hours processing time was 86.7% over a very small data set. Other researchers

like Menze et.al (2010) has reported an average overlap of 60% on the glioma patients which were 25 in number. Similarly Gooya et.al (2011) reported an average overlap of 74.5% on the glioma patients which were 15 in number along with this the processing time was between 6-14 hours. Oppositely Liu et.al (2005) reported an average overlap of 95.6% on a well performing subset of 5 patients over a 10 patient's dataset in which on the flair images the fuzzy clustering was done. He also pointed out that second method comprised of the extensive user correction and interaction with an average of 8.4 minutes per patient. To obtain a better segmentation the information was combined from the different sources. Work is being carried out for the betterment in the field of MRI protocol, various efforts are being made for the development of the better algorithms from the perspective of the image processing so that the information can be combined comprehensively with the each channel as it is the practical need in a clinical environment to quantify the tumours on a daily basis routine

Martelli (1976) has reported that any problem relating to the optimization can be formulated using the dynamic programming as the cost of the path graph search is minimum. A heuristic graph search algorithm was used by him it was taken from another researcher Nilsson. He used the above algorithm to the problems related to the boundary detections where the computation was affected and diminished as the search was prune because of the heuristics. This technique was able to identify the objects which were multi touching and with the help of the Gaussian noise the artificial boundaries were blocked. He also reported the formulated the directed graph of the image grid in which the corners of the pixels were considered as nodes and the directed arcs were the spaces or the graphs between the pixels. On the boundary shapes as well as the graph search no sampling or the searching constraints respectively were imposed in his current formulations same as his previous researches and the approaches used, which easily permitted the extraction of the arbitrary complexity path. The cumulative graph nodes costs were computed in the algorithm using a step wise fashion of the dynamic programming till within the image a path is computed which are optimal starting from a seed node and covering every node and connecting it to the seed node.

Morse et al. (1990, 1991) have reported an algorithm which computes the optimal boundary piece wise with multiple control input points. The method or the function used in this is probabilistic or the likelihood method as for the specific problems no constraints or th heuristics are specified. For the computation of the Bayesian probabilities particular feature distributions were provides using the manual training. The algorithm is iterated through the 2D likelihood matrix, the results obtained were complexity O(n3) where n stands for the height and the width of the image. The approach used in this method for the boundary findings is specific to the iterations and is non-interactive. The procedure of the dynamic programming already contains the series of the control points which were user selected an for the computation of the boundary it just needs few seconds.

Chan et.al (2001) has reported that in the segmentation of the image the widely used models are the active contours which are region based. For the segmentation process these have various benefits over the conventional gradient techniques like for noise they have a wide and broad robustness. Whereas comparing this to the classical contours the main difficulty with them was they can only perform according to the way as they initialised i.e their performance was according to their initialization, this was their major problem even when the levels were set in the surfaces of 3D. as there is no strong spatial prior of the class of tumour therefor many small structures like the blood vessels they are also classified as the tumor as the enhancement or the increment is seen in them.

Ho et al. (2002) has reported that to obtain a probability map of the tumor for the development of the level set surface, he used the pre and the post clasificatin of the contrast T1 images.

Liu et al (2005) have reported that by classifying and categorising the first and the last tumour slice along with the specification of the voxels set in the tumour region,

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using the above a regular volume of interest was constructed by him through this the segmentation of the tumor framework connection was accepted and modified by him in his studies.

Montanari et.al (1971) has reported for the first time the global optimisation algorithm for the detection of the boundary images. For the recognition of the system of lines which was based upon the dynamic programming was proposed by him. This technique is based on to minimise the cost function and a heuristic figure of merit and based on the intensity of the images the length and the curvature of the path, it develops a figure of merit for low curvature lines. The line is detected in an artificial image even though it is hardly visible due to the noise.

Grady et.al (2007) has reported that in the recent years the development of the interactive algorithms have become most popular these days. There is s generalisation of a framework of the seeded segmentation which is graph based like graph cute, random walker, power watersheds, shortest paths etc. the above describes methods are included in the special case of the seeded segmentation algorithm which solves the problem of the minimization using the weight constraints of the edge of the graph with the probabilities of the variables of the vertex which are adjacent to it. It was further exhibited in other studies that there is a connection between the random walker, graph cut and the shortest paths and were dependent on the basis of the optimization of the energies.

Sharp and Shapiro (2008, 2009) have reported that there was an incorporation of the geodesic distances in between the fore and the back ground of the seeds by using the other shortest path based segmentation algorithm.

Udupa (1989) has reported the dynamic reporting which was used for the formulation of the 2D boundary finding as a graph search.

Chien and Fu (1974) have reported the more general developed function criterion including both the components which are global and local. They were in opposition of the of Ballard and Sklansky as they thought that there developed function was very specific and was designed for only particular types of the applications. By using the modified tree search decision the criterion function was modified and this technique was applied in the x-rays of the chest to detect the boundaries of the heart or the cardiac region.

Szeliski et.al (2008) further reported that more seed dependent results were incorporated by the shortest paths and the random walkers the minimum global energy of the image segmentation is a s good as the capturing of the statistics which are underlying. Along with this a solution can be provided well and better by the local minimum than the global minimum for the ground truth. Therefore in the problem of the seeded image segmentation priorly a good amount of the information is provided beforehand, hence local minima is efficiently found which become significant, useful and valuable. On the other hand the biological motivation of the cellular automata algorithm is done from the competition and the growth of the bacteria which is defined on a lattice and is based on the dynamic system which is discrete and the propagation of the system is performed using the local transition rules and is done after every iteration.

Vezhnevets et al. (2005) have reported that for the segmentation of the image grow cut is the method which exhibits the CA algorithm potential for the image problems on the generic medical. Though this was not designed for the specific structures like the tumours as they have the necrotic and the tissues which are enhancing and growing and along with this the heterogeneous content is also displayed. The boundaries of the anatomic structures are smooth and the surface results produced by the grow cut methods is irregular and jiggered therefore for smoothing the surface only one technique could be used known as ad hoc. This method by using the user supplied seeds for interactively labelling the images, it utilised the cellular automata which was in a continuous state. The cells correspond to the image pixels and the grey scale intensities or the RGB is a feature vector. For each image pixel the state set comprises of the value of strength in a continuous interval, a label and an image feature vector. When the corresponding labels are assigned at seeds between the value of strength of 0 and 1 the initialization of the automata takes place. If the value comes to be higher than the confidence for choosing the seed is higher. For the

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unlabelled cells the strengths are set as 0. For the grow cut method the pseudo code is given below:

For Each Cell…

For $\forall_p \in P$

$$l^{t+1}{}_p = l^t_P$$

$$\theta^{t+1}{}_p = \theta^t_P$$

Neighbours try to attack current Cell..

$\forall_p \in N(p)$

$$g(\left\|\vec{C}_p - \vec{C}_q\right\|2).\theta^t_q > \theta^t_p$$

ss

$$l^{t+1}_p = l^t_q$$

$$\theta^{t+1}{}_p = g(\left\|\vec{C}_p - \vec{C}_q\right\|2).\theta^t_q$$

Alvino et.al (2007) has reported the shortest path ideas. He reported that the Eikonal equation can be solved using the different boundary conditions one constructed from the foreground seed and the other constructed from the back ground seed. On the right hand side of the Eikonal equation were added the seep functions which were dependent on the images and the solution of them leaded a path to the two distance functions: he shortest part of the foreground and the background seed from each and every pixel. The resulting segmentation was a result of the shortest distance from the foreground seed with each and every pixel.

O'Conner et.al (2008) reported comparative study of the four interactive segmentation algorithms. The successions of the user experiments were carried out in which the common data sets were extracted from the hundreds of the objects. They were further classified by twenty five with algorithm giving a time constraints of 2 minutes each object. For the interactive segmentation of the image a segmentation tool named as the scribble driven was developed for the experimentation work, in this the foreground and the background areas were simply marked using the mouse. The segmentation which was refined and the improved was masked and stored along with the elapsed time. Then the recorded mask was collected and evaluation was performed oppositely to the manual segmentation permitting accuracy with the time. For the purpose of the evaluation two benchmarks were used. They are: for the measurement of the accuracy of the objects Jaccard index was used and for the measurement of the accuracy of the boundary a new fuzzy metric was introduced. From the results obtained it was clear that the measures which were suggested by the author were effective and exhibited the valuable insights regarding the algorithms which were evaluated their performance and the characteristics enhanced and improved.

Kim et.al (2013) has reported PET which is positron emission topography for the segmentation of the tumour. This PET helps in the diagnosis of the clinical and also helps in evaluating the response of the treatment. It has some drawbacks which make the segmentation of the tumour a bit challenging like the resolution is low and the signal to noise is persisting in the images from the PET. There are various problems exiting like the manual segmentation is time consuming and simultaneously it is subjective also comparing it with the fully automated algorithms they have certain drawbacks too like they have limitation for some tumours and there is also a difficulty of the segmentation for those tumours which are small and of the low contrast. By applying this interactive segmentation it may diminish both it may reduce the input of the user and also decrease the variability of the inter observer. It was also exhibited by the author a novel interactive PET tumour segmentation method which was based on combining the CA (Cellular Automata) along with the ADF (nonlinear anisotropic diffusion filter). The benefit of using the combination is as the CA can tolerate the noise and the complexity of the patterns of the image and the function of ADF is to diminish or decrease the noise and protecting the edges. The author further explains that for the detection and the segmentation of the noisy tumours this approach or the method was more accurate, correct and robust. Various other common interactive PET segmentation algorithms were exhibited when they evaluated this method using the clinical data and the computer simulation.

Ganguly et.al (2003) has reported that the cellular automata is a computation model which is decentralised

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which having only the local information exhibits a complex computation giving the complex computations an outstanding and brilliant platform. Various scientists and the researchers from the different fields have browbeaten the local information of the CA paradigm etc. have been browbeaten for the modelling of the different application. The authors also reported various other survey an provides literature review regarding the methodologies which were used by different researchers who used the cellular automata for the purpose of the modelling. Different types of the cellular automata are introduced for modelling and the analytical methods are being used for the prediction of the global behaviour from the local configuration of the same. A description of the local settings of the CA configurations was also given from a global situation these are the inverse problems. It also reports the different types of the cellular automata applied in the various fields.

Bauer et.al (2013) has reported that the studies of the brain tumour which are based on the MRI medical images are seeking interest and the attention of researchers towards it in the present time. The main reason behind it is that for the evaluation of the huge data which should be done in an efficient manner. The current methods of the cellular automata are more closer and approx. to the routine clinical analysis as compared to the methods applied before one or two decades. This article introduces and provides an overview of brain tumours as well as the imaging process too. Further the segmentation, registration and the modelling all of their state-of-an-art were described with the brain tumours and a special attention was given to the gliomas. Delineation and the demarcation of the tumour along with its sub parts and the tissues covering it was the main and major aim of the segmentation. Apart from this the major challenge residing with the modelling and the registration was the morphological changes which the tumour produced, to handle this morphological change was the major issue in registration and the modelling. Further, the author discussed about the various approaches, their qualities, their methods for the application on standard clinical imaging protocols. He also discussed about the evaluation of the current methods along within the growth which can take place in the future i.e. growth in future were discussed and the detailed description of the current methods giving a special focus on the guidelines of the radiological tumour evaluation were also reported.

Duffau et.al (2007) has reported that for the detection of the gliomas dynamics on MRI is significant for the therapeutic management. Some computational tools which were powerful were developed recently and they enabled the comparison of the virtual brain with a real 3D segmented evolution using the registration process between the virtual and the data of the MRI of brain of the patients. The in silico growth was enabled on the virtual brain. The author also exhibited the review over the present algorithms specifically for the three computational tasks of tumour modelling they are the image registration, image segmentation and the in silico growth modelling. The limit as well as the accuracy of the algorithms were further evaluated and discussed. The fundamental research and the clinical practises of the methods of these applications were also demonstrated in this article.

Grady (2006) has reported a new method for the interactive image segmentation for the multilabel performance was described. A small number of pixels along with the pre-determined labels were given for the analytical and fast determination of the probability that the random walker will first reach the pre-labelled pixels (any one of them) starting from each under labelled pixel. We obtain an image segmentation which is of the higher quality by transferring the pixel to label which calculated the greatest probability. The theoretical properties along with the electrical circuits and the potential theory connections of the algorithms were developed. The formulation of the algorithm was performed on the graph or in the discrete space, combining them with the analogues of the standard operators and the principles from the potential theory which was permitted to be used in the arbitrary graphs.

Kim et.al (2010) has reported a new method for the volume segmentation of the 3D brain tumour which is based on the framework of the cellular automata. The prior label knowledge which is gathered is incorporated from the user seed information to influence the decision rules of the cellular automata. By using any number of the label classification this method accurately and quickly segments the volumes of the brain tumour. The

parallelism of the present algorithm is manipulated and was used for the GPU (Graphics Processing Unit). The individual label strength maps were also incorporated. The main advantages of the systems are speed, robustness, and accuracy for the complex structures. Comparing with the conventional methods of the CPU the computations of the segments were approximately 45 times faster and this speed enables at the interactive rates the feedbacks of the user.

CONCLUSION

In this paper we discussed about various types of image segmentation techniques which is used for different-different purpose for analysis images like detection of the boundary images, common data extraction from various huge amount of data, etc. In this paper various problems also noticed like low resolution of image(medical), signal to noise is persisting in the images, etc. Through this servey we noticed that a single method can not be consider for all type of images, so hybrid solution for image segmentation is the best solution.

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REFERENCES:

1. B. Chitradevi, P.Srimathi, An Overview on Image Processing Techniques, International Journal of Innovative Research in Computer and Communication Engineering, ISSN ONLINE(2320-9801) PRINT (2320-9798)

2. Kevin McGuinness, Noel E. O'Connor, A Comparative Evaluation of Interactive Segmentation Algorithms.

3. Leo Grady, Random Walks for Image Segmentation, IEEE Transactions On Pattern Analysis And Machine Intelligence, Vol. 28, No. 11, Nov. 2006.

4. Dilpreet Kaur1 , Yadwinder Kaur, Various Image Segmentation Techniques: A Review, International Journal of Computer Science and Mobile Computing, Vol.3 Issue.5, May- 2014, pg. 809-814

5. Vidushi Sharma, Anurag Dev, Sachin Rai, A Comprehensive Study of Cellular Automata, International Journal of Advanced Research in Computer Science and Software Engineering, Volume 2, Issue 10, October 2012.

6. Debasis Das, A Survey on Cellular Automata and Its Applications, DOI: 10.1007/978-3-642-29219-4_84, Conference: 4th International Conference, ObCom 2011.

7. Schiff, Joel L. Cellular automata: a discrete view of the world. Vol. 45. John Wiley & Sons, 2011.

8. REESE, L. 1999. Intelligent Paint: Region-Based Interactive Image Segmentation. Master's thesis, Department of Computer Science, Brigham Young University, Provo, UT.

9. MORTENSEN, E. N., AND BARRETT, W. A. 1998. Interactive segmentation with intelligent scissors. Graphical Models and Image Processing 60, 5, 349–384.

10. D. H. Ballard and J. Sklansky, "Tumor Detection in Radiographs", Computers and Biomedical Research, Vol. 6, No. 4, pp. 299-321, Aug. 1973.

11. J. D. Cappelletti and A. Rosenfeld, "Three-Dimensional Boundary Following," Computer Vision, Graphics, and Image Processing, Vol. 48, No. 1, pp. 80-92, Oct. 1989.

12. Y. P. Chien and K. S. Fu, "A Decision Function Method for Boundary Detection" Computer Graphics and Image Processing, Vol. 3, No. 2, pp. 125-140, June 1974.

13. A. Martelli, "An Application of Heuristic Search Methods to Edge and Contour Detection," Communications of the ACM, Vol. 19, No. 2, pp. 73-83, Feb. 1976.

14. U. Montanari, "On the Optimal Detection of Curves in Noisy Pictures," Communication of the ACM, Vol. 14, No. 5, pp. 335-345, May 1971.