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# An Innovative Region Growing and Region Merging Image segmentation Method

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**ABSTRACT**: Using predetermined criteria, region growth is a process that aggregates pixels or subregions into layer regions. Starting with a set of seed points, the primary strategy is to develop areas by adding nearby pixels to each seed that have characteristics comparable to the seed. For the uncontrolled segmentation of colour images, we suggest a unique approach. The suggested method uses dynamic colour gradient thresholding to control how the region grows. A weighted vector-based colour gradient map is produced from a colour picture. A dynamic threshold is then applied to reliably grow regions on the weighted gradient map after seeds have been found. To create the last segmented image, over-segmentation, if any, is dealt with by a region merging phase based on measurements of similarity. Comparative outcomes show how good this algorithm is in segmenting colored images.

**KEYWORDS**: Image Segmentation, Seed generation, Region Growing, region Merging

## I. INTRODUCTION

The basic presumption of region-growing techniques is that adjacent pixels within one region will have comparable values. The usual practise is to evaluate one pixel in relation to its neighbours. The pixel may be designated as one or more of its neighbours in the cluster if a similarity condition is met. The results are always affected by noise, and the choice of the similarity criterion is significant. In addition to the image, this technique also accepts a set of seeds as input. Each of the segmentation targets is identified by the seeds. By comparing all of the neighbouring pixels that have not been allocated, the regions are iteratively enlarged. As a metric of resemblance the disparity between a pixel's value of intensity and the region's mean is employed. The region-specific pixel is the one with the least difference as determined in this manner. This procedure is repeated until every pixel has been allocated to a region. The segmentation outcomes rely on the selection of seeds since seeded region growing needs seeds as another input, and noise in a picture can result in the seeds being improperly positioned. Fig. 1 shows effect of seed generation in an image[1]. Partitioning an image into areas is the goal of segmentation. Instead of segmenting using thresholds according to the spread of pixel attributes, such as colour or gray-level values, we chose to establish borders between sections based on disruptions in grey levels.

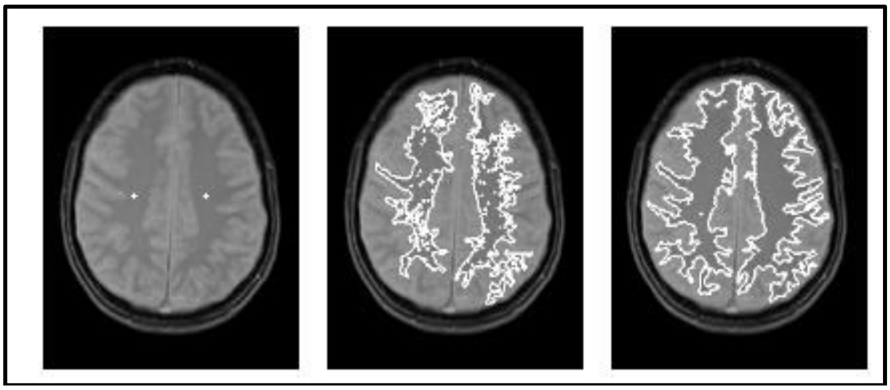

Fig. 1: Effect of seed generation in an Image

Growing persists until a stopping regulation is put into place. Practical issues with the region's growing include how to choose the seed sites for the growing rule (or regular parameter) and the halting rule. Let R be the region of the image as a whole. We can think of segmentation as a procedure that divides R into n segments, R1, R 2,..., Rn, so that the condition is tested using the predicate P(Ri). If P(Ri)=true in any location, the picture is partitioned into different subpictures. Partition the picture into quadrants if P(Ri) = false. The quadrants should then be further divided into sub-quadrants if P(Ri) = false.

## II. REGION GROWING

Region growth, as its name suggests, is a process that divides pixels or smaller regions into larger regions according to predetermined standards. The fundamental strategy is to begin with an array of "seed" points and expand territories from these seeds by adding to each seed those nearby pixels that have characteristics with the seed (like particular ranges of grayscale or colour). The method is to compute the same set of attributes at each pixel when a priori knowledge is not provided. This computation will be utilised for allocating pixels to areas during the growth process. The pixels whose characteristics place them close to the centroid of these clusters can be utilised as seeds if the output of these computations reveals groupings of values. The choice of similarity criteria is influenced by the sort of picture data that is available as well as the problem that is being considered. For instance, the use of colour is crucial when analysing land-use satellite images. Without the underlying information contained in colour photos, handling this issue would be substantially more challenging, if not impossible. When the images are black-and-white, region analysis must be done using a set of descriptions based on the spatial characteristics (such as moments or texture) and the grey levels of the pictures.

In general, a region should stop expanding when no more pixels meet the requirements for admission in that region. Grey level, texture, and colour are examples of local criteria that do not consider the "history" of regional expansion. The idea of size, similarity between the prospective pixel and the pixels grown thus far (for instance, an examination of the candidate's grey level and the median grey level of the grown section), and the contours of the region being developed are additional factors that boost the effectiveness of a region growing algorithm. These descriptors are utilised with the presumption that an illustration of anticipated outcomes is at least partly accessible.

## III. REGION MERGING OR SPLITTING

A picture is separated into numerous subimages of disconnected parts using this approach, and the related portions are subsequently combined. In the process just described, a collection of seed points are used to grow regions. Another option is to initially divide an image into a number of random, disconnected parts, and then to merge and/or separate the regions in an effort to meet the requirements. Iteratively working towards meeting these requirements, a split and merge mechanism is created. Choose a predicate P, and let R stand in for the full image region. One method of segmenting R is by separating it into gradually smaller and smaller quadrant regions, ensuring that P(Ri) = TRUE for every region. Beginning with the entire area. We split the image into four quadrants if P(R) = FALSE. We split a quadrant into sub-quadrants and so on if P is FALSE for any of the quadrants. An easy way to visualise this specific splitting method is in the shape of a "quad tree," which is a tree in which every node has precisely four descendants. The full image is represented by the tree's root, while each node represents a subdivision. Only R4 was additionally separated in this instance.

- If P(Ri)=FALSE, divide any region Ri into 4 separate quadrants.
- For all nearby areas Rj and Rk with P(RjURk)=TRUE, combine them.
- When there is no more room for merging or splitting, stop.

If dividing were the only technique utilised, the final division most likely would have nearby sections with the same characteristics. By permitting both splitting and merging, this flaw could be fixed. Only adjacent areas whose requirements are met must be merged. The basic concept discussed earlier has a number of possible modifications. One option, for instance, is to initially divide the image into a number of blocks. However, merging is first restricted to a set of four blocks that are successors in the quadtree description and that meet the predicate P. Additional splitting is carried out as already mentioned. When no more of these types of mergings are conceivable, step 2 is satisfied by one last merging of the regions. The merged zones may be distinct in size at this point. This method's main benefit is that it uses identical quadtree for splitting and merging up until the very last stage of merging.

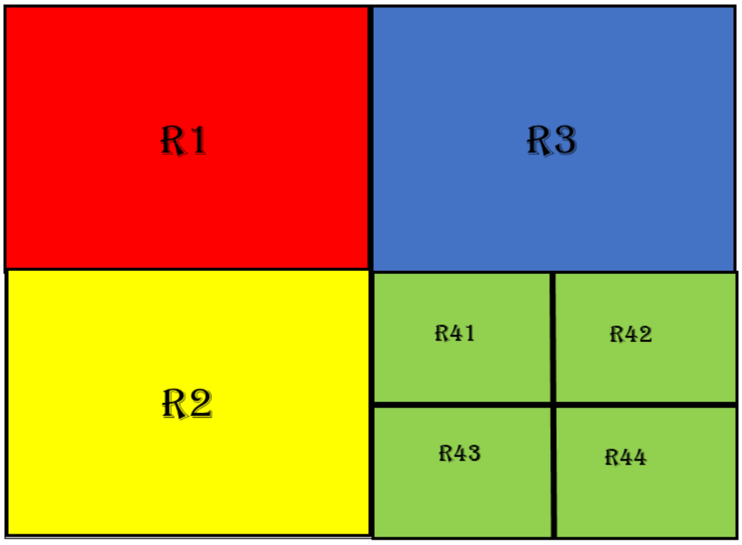


Fig. 2: Region Splitting with Seed

In this research, we present a hybrid methodology that combines Otsu's automatic threshold and the vector-based colour gradient method to achieve dynamic threshold-based segmentation. Colour image segmentation is the most logical technique (owing to the extra colour material) to obtain comparable segmentation outcomes utilising automated methods, given that human vision employs colour information to discern features. Our method emphasises the usage of color-homogenous regions and colour transitions while avoiding the generation of edges when doing segmentation. The problems of thresholding and disjointed edges are avoided when colour gradients are used to help in the region growth process rather than for creating edges.

In our method, seeds emerge and automatic region growing depends on a weighted vector-based colour gradient map. In this context, "seeds" refers to a connected 4-neighborhood collection of pixels whose gradient is beneath a predetermined threshold. The growth phase is controlled by the dynamic threshold operator used on this gradient map. Region growth is followed by a region-merging step based on similarity measures to guarantee that the segmentation is consistent with the image regions. This results in a segmented image that is perfect. The grayscale image with L unique gradient values that makes up the vector-based colour gradient map. Greater gradient values correspond to colour edges, whereas lower gradient values indicate areas with uniform colour. We compute an ideal threshold automatically using Otsu's method [2] to distinguish the region inside from the edge pixels. The colour gradient map needs to be processed effectively to emphasise the edges that are both powerful and fragile while minimising low gradient areas. Utilising intensity clipping and stretching techniques, the gradient map's global gray-level contrast is first adjusted. Prior to that, consider pixels with gradient values between 10% and 90% of the maximum. The range from 0 to 1 is used to map gradient values. The Extended Gradient Map GE is the outcome of these procedures. The Line Field [3] and Threshold Maps are then used in a masking procedure that follows.

The ultimate segmentation's quality is greatly influenced by the selection of the seeds. Therefore, it is essential to produce seeds within each prospective segment in order to prevent under-segmentation problems. The weighted gradient map's low gradient sections make great seed choices for promoting region growth.Any seed groups that meet the required minimum seed size requirement (i.e., have a significant pixel count) are kept and passed as input seeds for the region developing stage in order to maintain consistency. After the first seed generation, we put into practise a dynamic thresholding strategy that, when combined iteratively with Otsu's automatic threshold, offers an unsupervised way to produce trustworthy pixels for region growing.

the first ideal threshold Ti acts as the upper limit for the seed generation process's classification of foreground pixels. The gradient map's residual unclassified pixels are then used as input data for the subsequent thresholding level once the seeds have been produced. The initial threshold's main distinction. Their generation is based on Ti and the present threshold T2. On the whole collection of pixels, the first threshold was calculated using Otsu's approach. In contrast, just a collection of pixels that are still unclassified are used to calculate the new threshold using Otsu's technique.

As a result, with every round of region growth, the variable threshold rises. This rise makes sure that each iteration of region growth travels from the core areas—which represent homogeneous regions without boundaries—toward the edges. Additional core pixels are added to the growing region's collection of pixels via each dynamic updating of the threshold, but the edge pixels are left unclassified until the very end of growth. This action is crucial because it guarantees that sharp edges are never buried. It is also noteworthy that segmentation is now possible without requiring the identification of binary edges. Thus, the method resolves problems caused by jagged edges and loudness.

Determine pixels whose gradient values fall below the upper bound U after the seed generation step. If these pixels are not a member of the seed group, group them according to their connectedness across four neighbourhoods and label them as growth regions. Determine the growing areas that are close to the seeds and mark them as potential areas. Label the seed that shares the most pixels with its neighbours as the region's parent seed for each prospective region. This guarantees that the parent seed and the future region have a lot of characteristics. If a potential area meets the merging criteria, integrate it to its parent seed [4].

If a prospective region's size is smaller than a certain number of pixels (the minimum region size), combine it immediately with the seed. If the potential region's size is more than the minimum region size, it should only be combined with the seed if it has a sufficient number of adjacent pixels and corresponds to the seed in terms of mean colour variation. The simultaneous merging conditions makes sure that although small possibilities combine readily, large potential regions merge to the seed restrictively. This causes very few, if any, faults in growth of seeds. If a growing region misses stages (does not have any parent seeds or fails to meet the merging condition), but satisfies the minimal seed size criterion, it should be given a new seed status. Include these fresh seeds in the current seed group[5].

Any legitimate seeds that could have eluded the initial seed generating stage are caught in this step of fluid seed generation. As a result, it prevents different regions from mistakenly merging (under-segmentation) with their neighbours as a result of the absence of a parent seed [6].

The phase of region merging comes after a stage of region growth. This is essential because area growing was accomplished utilising a variety of seeds, some of which may have come from the same region. As a result, it is desirable for a region to contain many partitions [7]. By merging these partitions based on an analogous standard, these over-segmentation difficulties can be solved. Using the region-grown map that was produced during the region-growing stage as a point of departure, calculate the mean and covariance values for each region and its surrounding areas. Update the updated region-neighborhood data and merge regions with their neighbours if they fall below a minimal pixel count [8].

## IV. EXPERIMENTAL RESULTS

A large number of seeds have engaged in the growth process, as seen by the growing amount of segments. As can be seen, every region is excessively segmented and does not correspond well to the predicted region boundaries.

The segments by themselves, meanwhile, clearly fall inside the predicted region segments, and it is highly uncommon for segments to cross boundaries. In order to prevent under-segmentation problems, the approach effectively attains a high level of precision in determining region borders and ensures that the edges are not buried. After effectively merging the over-segmented regions, a segmentation outcome that corresponds with image regions is produced.

Utilising Matlab 2014a, the suggested algorithm was put into practise and evaluated on an array of RGB images that ranged in complexity from straightforward to intricate in terms of colour changes and details.

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Fig 3.: Input Image segmentation with scale 1


Fig.4: Input Image segmentation with scale 2


Fig. 5: Input Image segmentation with scale 3


Fig. 6: Input Image segmentation with scale 4

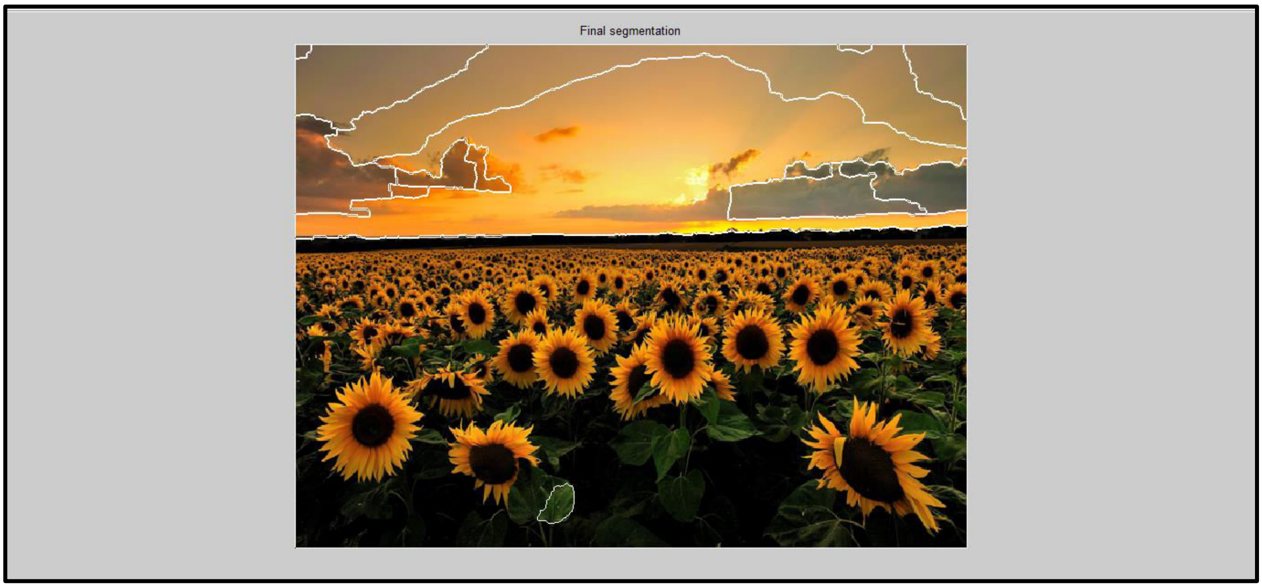


Fig. 7: Final Image segmentation and Merging

## V. CONCLUSION

Image segmentation is a crucial method for drawing out intriguing elements from images since it divides a picture into its component pieces. For a variety of purposes over the past few decades, numerous effective picture segmentation algorithms have been developed. However, it remains a difficult and complicated problem, particularly for colour picture segmentation. For the unsupervised segmentation of colour images, we suggest a unique approach. The suggested method uses dynamic colour gradient thresholding to control how the region grows. A weighted vector-based colour gradient map is produced from a colour picture. A dynamic threshold is then applied to reliably grow regions on the weighted gradient map after seeds have been found. To create the ultimate segmented image, over-segmentation, if any, is dealt with by a region merging stage based on measurements of similarity. Comparative outcomes show how effective this method is for segmenting colour images.

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