УДК 621.391

AN AUTOMATIC SEEDED REGION GROWING ALGORITHMBASED ON CONTOUR PROCESSING FOR GRAYSCALE IMAGES

Аль-Фурайджи О. Дж. М.[1], Аль-Мансури Х. А.[2], Цветков В. Ю. [3]

Университет Шатт Аль-Араб[1], г. Басра, Ирак

Белорусский государственный университет информатики и радиоэлектроники[2,3], г. Минск, Республика Беларусь

Аль-Фурайджи О. Дж. М. – к. т. н., доцент кафедра информатики

Цветков В.Ю. – д.т.н., профессор

Аннотация. In this paper, an automatic seeded region growing algorithm based on contour processing for grayscale images is proposed. In which, the grayscale image is first read. After that, the image is subjected to contour processing. The contour image is then segmented using simple SRG by assigning labels to each pixel in a specific segment. The segmented image is then compared to original input image to find the suitable seed in the segment depending on the average brightness of pixels forming the segment. Then these seeds are used again to generate segments using SRG algorithm. The proposed algorithm is shown that it is more accurate in finding number of segments than traditional segmentation algorithms.

Ключевые слова. Image segmentation, Seeded Region Growing, Contour processing, Region of interest, Pixel brightness.

Segmentation refers to the process of partitioning a digital image into multiple regions (sets of pixels). The goal of segmentation is to change the representation of an image into something that is more meaningful and easier to analyze. More precisely, image segmentation is the process of grouping an image into units or categories that are homogeneous with respect to one or more characteristics. The result of image segmentation is a set of segments that collectively cover the entire image, or a set of contours extracted from the image.

In 1997, C. Revol and M. Jourlin proposed an image segmentation algorithm with a homogeneity criterion based on an adequate tuning between spatial neighborhood and histogram neighborhood [1]. In 2001, I. Grinias and G. Tziritas introduced a semi-automatic method for moving object segmentation and tracking. The method is suitable when a few objects have to be tracked, while the camera moves and fixates on them [2].

In 2005, J.I. Kwak, [et al.] developed a rate-distortion (RD) based seeded region growing (SRG) algorithm for extracting an object such as breast tumors in ultrasound volumes which contain speckle noise and indistinct edges. In which, region growing proceeds in such a way that the growing cost is minimized which is represented as the combination of rate measuring the roughness of a region contour and distortion measuring the inhomogeneity of pixels in a region [3].

In 2007, O. Gomez, [et al.] suggested an automatic seeded region growing algorithm called ASRG-IB1 that performs the segmentation of color (RGB) and multispectral images. The seeds are automatically generated via histogram analysis; the histogram of each band is analyzed to obtain intervals of representative pixel values [4]. In 2009, M. del Fresno, [et al.] introduced a hybrid 3D image segmentation method which combines region growing and deformable models to obtain accurate and topologically preserving surface structures of anatomical objects of interest [5].

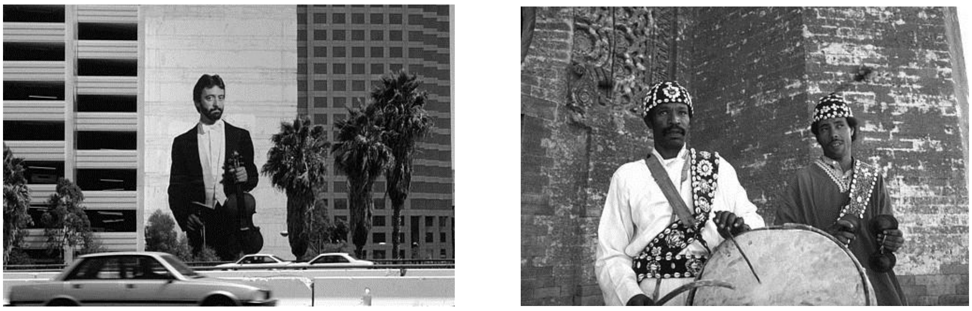
In 2010, J. -L. Rose, [et al.] proposed a new framework using a variational approach that is called Variational Region Growing (VRG). Variational approach is commonly used in image segmentation methods such as active contours or level sets, but is rather original in the context of region growing. It relies on an evolution equation derived from an energy minimization, that drives the evolving region towards the targeted solution [6]. In 2012, M. Mary Synthuja Jain Preetha, [et al.] presented an automatic seeded region growing algorithm for segmenting color images [7].

In 2015, M. Fan and T.C. M. Lee developed new modifications to SRG so that the constant grey value assumption is relaxed. Since the growing strategy of SRG does not impose any constraints or restrictions on the shapes of the growing regions, quite often SRG would produce very rough segmentation boundaries even the true boundaries were smooth. Also, they proposed a stabilized SRG that encourages smoother boundaries and prevents the so-called leakage problem [8]. In 2018, Y. Ge, [et al.] developed a modified region growing (MRG) algorithm, which is characterized by more efficient grow criterion, and was used to recognize discontinuities from the point cloud [9].

In 2020, M. F. Ramli and K. N. Tahar introduced a study to evaluate the height of oil palm tree based on crown diameter by using a multi-rotor Unmanned Aerial Vehicle (UAV). Digital Elevation Model (DEM) and orthophoto were generated by using Agisoft software, while oil palm tree crown diameter was delineated by using seed generation with Quantum Geographic Information System (QGIS) and Seeded Region Growing (SRG) segmentation methods in the System for Automated Geoscientific Analysis (SAGA) [10].

In 2021, X. Hu, [et al.] proposed a region growing segmentation method based on microparticle color and grayscale information, in which the fuzzy contrast enhancement algorithm is used to enhance the color information of micro-particles and improve the discrimination between the micro-particles and background. In the HSV color space with stable color, the color information of micro-particles is extracted as seed points to eliminate the influence of light and reduce the interference of impurities to locate the distribution area of micro-particles accurately [11].

The aim of this paper is to automatically find the seeds which represent the center of segment, based on the average pixels' brightness of region of interest in the input image. These seeds then grow according to the simple SRG algorithm to find the segments of the input image. The grayscale image is first read, Fig. 1. After that, the image is subjected to contour processing, Fig. 2. The contour image is then segmented using simple SRG by assigning labels to each pixel in a specific segment, Fig. 3. The segmented image is then compared to original input image to find the suitable seed in the segment depending on the average brightness of pixels forming the segment, Fig.4. Then these seeds are used again to generate segments using SRG algorithm, Fig. 5. The proposed SRG algorithm described in the flowchart shown in Fig. 6, and the proposed algorithm is depicted visually as shown in Fig. 7. The resulted seeds and their pixel values are given in Table 1.



a) b)

Figure 1 – Test input grayscale images

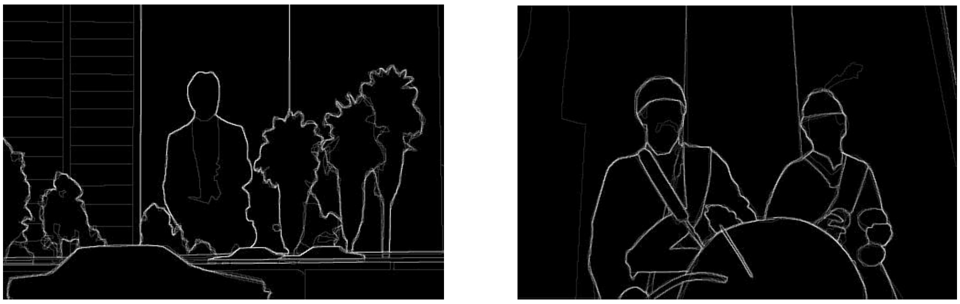


Figure 2 – Contour images

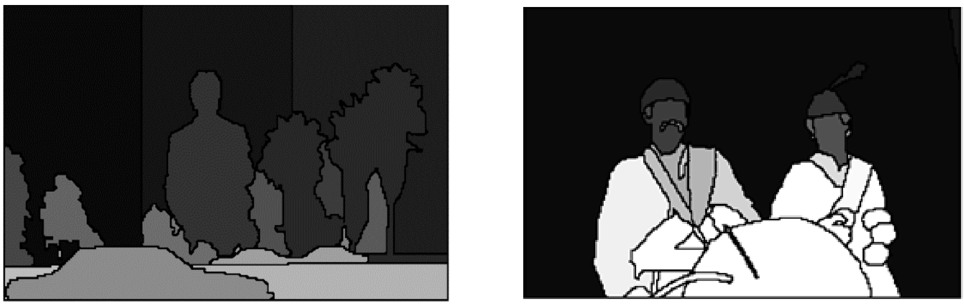


Figure 3 – Resulted labeled segmented images

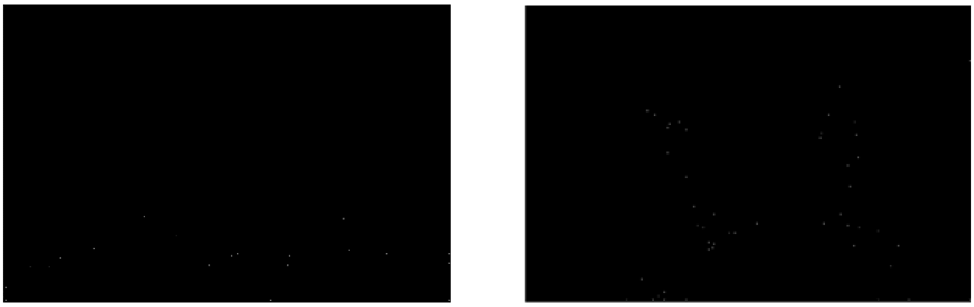


Figure 4 – Resulted seeds based on the average brightness of pixels in the segment

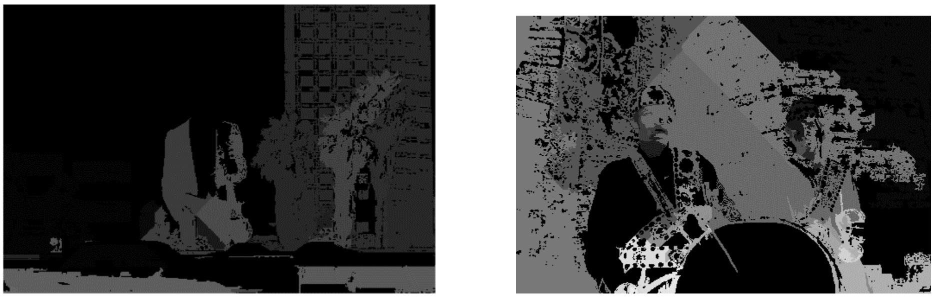


Figure 5 – Generated segments from seeds

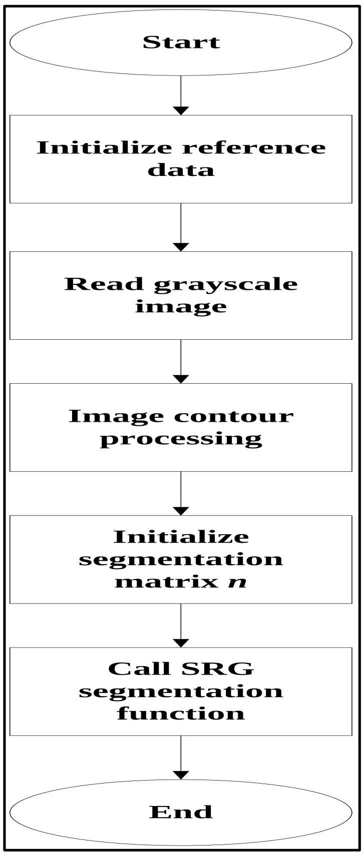


Figure 6 – The proposed SRG algorithm flowchart

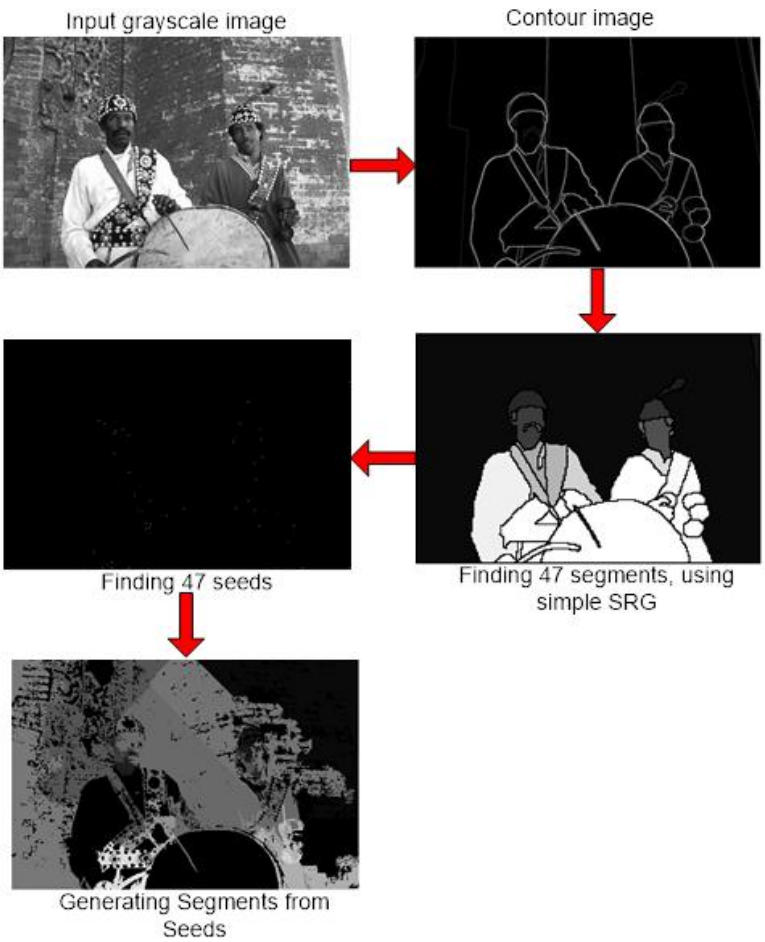


Figure 7 – The proposed SRG algorithm visual description

Table 1 – Resulted coordinates of seeds and their pixel values, for test image Fig. 1(b).

Segment number	Average pixel value in the segment	Rows	Columns
1	76	319	479
2	252	62	479
3	81	90	339
4	47	116	132
5	137	120	327
6	71	161	154
7	16	120	140
8	93	175	348
9	20	128	355
10	34	140	319
11	48	128	166
12	48	130	156

Segment number	Average pixel value in the segment	Rows	Columns
13	7	136	174
14	21	134	154
15	41	142	357
16	85	145	318
17	145	219	182
18	16	241	192
19	11	239	186
20	100	187	174
21	247	237	250
22	37	197	350
23	169	166	359
24	190	319	110
25	45	227	340
26	60	237	322
27	75	319	413
28	43	247	220
29	255	227	204
30	44	241	360
31	25	245	380
32	69	297	126
33	68	261	354
34	171	259	204
35	195	319	380
36	20	239	348
37	69	261	402
38	26	257	198
39	37	247	226
40	70	265	198
41	32	263	202
42	29	283	394
43	66	315	144
44	208	311	150
45	38	319	150
46	155	319	174

Segment number	Average pixel value in the segment	Rows	Columns
47	39	319	138

References:

1. A new minimum variance region growing algorithm for image segmentation / C. Revol, M. Jourlin // Pattern Recognition Letters, 1997. – P. 249-258.
2. A semi-automatic seeded region growing algorithm for video object localization and tracking / I. Grinias, G. Tziritas // Signal Processing: Image Communication, 2001. – P. 977-986.
3. RD-Based seeded region growing for extraction of breast tumor in an ultrasound volume / J.I. Kwak, [et al.] // Computational Intelligence and Security, 2005. – P. 799-808.
4. Image segmentation using automatic seeded region growing and instance-based learning / O. Gomez, [et al.] // Progress in Pattern Recognition, Image Analysis and Applications, 2007. – P. 192-201.
5. A combined region growing and deformable model method for extraction of closed surfaces in 3D CT and MRI scans / M. del Fresno, [et al.] // Computerized Medical Imaging and Graphics, 2009. – P. 369-376.
6. Unifying variational approach and region growing segmentation / J. -L. Rose, [et al.] // European Signal Processing Conference, Aalborg, Denmark, 2010. – P. 1781-1785.
7. Image segmentation using seeded region growing / M. Mary Synthuja Jain Preetha, [et al.] // International Conference on Computing, Electronics and Electrical Technologies (ICCEET), Nagercoil, India, 2012. – P. 576-583.
8. Variants of seeded region growing / M. Fan, T.C.M. Lee // IET Image Processing, 2015. – P. 478-485.
9. Automated measurements of discontinuity geometric properties from a 3D-point cloud based on a modified region growing algorithm / Y. Ge, [et al.] // Engineering Geology, 2018. – P. 44-54.
10. Homogeneous tree height derivation from tree crown delineation using Seeded Region Growing (SRG) segmentation / M. F. Ramli and K. N. Tahar // Geo-spatial Information Science, 2020. – P. 195-208.
11. Research on the Region-Growing and segmentation technology of micro-particle microscopic images based on color features / X. Hu, [et al.] // Symmetry, 2021. – P. 1-17.