

A Connected Components Labeling Algorithm for 4- Connectivity Based On Position Matrix

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ABSTRACT

Connected components labeling of a binary image is one of the important operation in image processing. This paper proposes a new connected component labeling algorithm to label the connected components based on 4 connectivity and reports the number of components present in the binary image. This algorithm is based on the position value of the foreground pixel of the image. The connected components are identified are assigned by a unique label. Experiments are conducted by applying proper thresholding technique on various images from the datasets collected and tagged by the ICDAR Robust Reading Dataset Collection Team.

Keywords : Image Processing, Labeling, Connected Component, Object extraction

I. INTRODUCTION

Connected Component Labeling (CCL) in an image is a vital operation in pattern recognition systems. CCL algorithm assigns unique labels to different, disjoint connected components. Fu Chang [1] et.al used contour tracing technique to detect component contours by a single pass to assign a label. Yuhai [2] et.al proposed a method based on sequentially processing two adjacent rows for labeling connected components in binary images. Phaisarn [3] et.al proposed pixel-based scan mask and the block-based scan mask scan masks for connected components labeling in binary image. Mehdi[4] et.al provided a parallel version of Suzuki's sequential connected component algorithm in order to speed up the labeling process. Rakhmadi[5] et.al technique reduced the searching time for locating the object by focusing only on the suspected object based on certain features defined. Tetsuo [6] et.al presented two in-place algorithms which run in linear time and need no extra array other than an input array for labeling the connected components. The Positional Connected Component Labeling (PCCL) algorithm proposed by Gayathri et.al [7] is based on 8-connectivity to find all connected components in an image. In this paper a very effective 4 way connected

component connecting algorithm is proposed to label connected components in a binary image.

II. PROPOSED WORK

A set of pixels in which each pixel is connected to all other pixels is called a connected Component. 4-Connected pixels are neighbors to every pixel that touches one of their edges. These pixels are connected horizontally and vertically i.e every pixel that has the coordinates $(x\pm 1, y)$ or $(x, y\pm 1)$ is connected to the pixel at (x, y) . A component labeling algorithm finds all connected components in an image and assigns a unique label to all points in the same component. The proposed Positional Connected Component Labeling (PCCL) algorithm is based on 4-connectivity to find all connected components in an image, assigns an unique label to all points in the same component and find number of components present in the image. The algorithm for PCCL is based on the position of the white pixels in the image and is formulated as follows:

POSITIONAL 4 CONNECTED COMPONENT LABELING ALGORITHM

Input: Binary Image Matrix (I)

Output: Connected Component Labeled Matrix (L),
Numbers_of_Components

- Step 1.** Find the foreground (white) pixel and record the foreground column position of the binary matrix image in a matrix (Position Matrix).
- Step 2.** Unmark all the cells of the Position Matrix(PM).
- Step 3.** Find the minimum position value (MinPos) and maximum position value (MaxPos) from the Position Matrix.
- Step 4.** Set the value of LABEL to 1. .Current Row (CR) to 1.AV [] = {}, PV [] = {}
- Step 5.** Get the first unmarked value (umv) from the Position Matrix (PV [] =umv).Set CR to the Row Number of umv. FLAG= NOTPREVMARKED. L=LABEL.If no unmarked cell found, then go to step 16.
- Step 6.** Find out the adjacent value (AVCR []) of the position values (PV []) from PM. The adjacent values are P-1, P and P+1 for a value P. If P is to be MinPos, then the adjacent values are P and P+1. If P is to be MaxPos, then the adjacent values are P-1 and P.
- Step 7.** Find out the adjacent value (AVOR[]) of the position values (PV []) from PM. i.e AVOR [] = PV []
- Step 8.** Search for the AVCR [] in the CR and AVOR [] in CR - 1 and CR + 1. Mark the corresponding cell. If any of these cells are already Labeled by the previous pass, change the FLAG= PREVMARKED, L= Label assigned to the already Labeled cell .(Do not include CR - 1 for the first row and CR + 1 for the last row).
- Step 9.** Increment CR by one.
- Step 10.** Scan CR and find the adjacent values (AVCR []) of cells marked by step 7 in the row CR.
- Step 11.** Go to step 6 if PV[] = ∅ or CR > LAST ROW.
- Step 12.** Assign L value for the corresponding cells marked during this pass in the Input Image (I).
- Step 13.** If FLAG IS NOTPREVMARKED then increment LABEL value by one.
- Step 14.** If any unmarked cells found go to step 5.
- Step 15.** Number_of_Components= LABEL - 1.
- Step 16.** Stop the procedure.

To illustrate the proposed method, a small binary image Fig 1 is taken. The column position of white pixel in

image is recorded in a matrix called position matrix is (Fig 2). The values of MinPos, Maxpos are 1 and 10 respectively known from fig 1.

1	1	1	0	0	0	1	0	0	1
0	1	1	0	0	1	0	1	0	1
0	0	0	0	1	0	1	0	0	1
0	0	0	1	0	1	0	1	1	0
0	0	1	1	0	1	1	0	1	0
1	1	0	0	1	1	0	0	1	1
0	1	1	1	0	0	1	1	1	0

Fig 1: Input Image

1	2	3	7	10	
2	3	6	8	10	
5	7	10			
4	6	8	9		
3	4	6	7	9	
1	2	5	6	9	10
2	3	4	7	8	9

Fig 2: Position Matrix

Matrix

Initialization:

Set LABEL= 1, CR=1, MinPos=1, MaxPos=10. L=1 (LABEL)

PASS I:

Get the first unmarked value (Fig 3a) from the Position Matrix. The unmarked value is 1(found in ROW 1, so CR=1) PV [] = {1}, FLAG= NOTPREVMARKED according to step 5.

Pass i: The adjacent values of 1 are 1 and 2. AVCR [] = {1, 2}. CR=1. The adjacent values of 1 are 1 according to step 7 i.e AVOR[]={1}.The AVCR[] values are searched in CR and AVOR[] in CR+1 and those cells (1, 2 in Row 1) are marked (Fig 3b). Now CR is incremented by 1 (CR =2). The cell marked in CR is NIL (PV [] = {}). There is no cell marked in Row 2 (PV [] = ∅).First Pass is Over. Assign L to the corresponding marked cells in the Input Image (Fig 3c). As FLAG is NOTPREVMARKED , LABEL is incremented by one (LABEL =2).

1	2	3	7	10	
2	3	6	8	10	
5	7	10			
4	6	8	9		
3	4	6	7	9	
1	2	5	6	9	10
2	3	4	7	8	9

1	2	3	7	10	
2	3	6	8	10	
5	7	10			
4	6	8	9		
3	4	6	7	9	
1	2	5	6	9	10
2	3	4	7	8	9

1	1	1	0	0	0	1	0	0	1
0	1	1	0	0	1	0	1	0	1
0	0	0	1	0	1	0	1	0	1
0	0	0	1	0	1	0	1	1	0
0	0	1	1	0	1	1	0	1	0
1	1	0	0	1	1	0	0	1	1
0	1	1	1	0	0	1	1	1	0

Fig 3: (a) (b) (c)

(a) 1st Unmarked Cell (b) Pass I- i (c) Output of Pass I

PASS II:

Get the first unmarked value (Fig 4a) from the Position Matrix. The unmarked value is 3(found in ROW 1, so CR=1) PV [] = {1}, FLAG= NOTPREVMARKED

according to step 5. L=2 as LABEL=2. Pass i: The adjacent values of 3 are 2, 3 and 4. AVCR [] = {2, 3, 4}. The adjacent value of 3 is 3 according to step 7 i.e AVOR[]={3}. The AVCR[] values are searched in CR and AVOR[] in CR+1 and those cells (2 in Row 1 and 3 in Row 2) are marked (Fig 4b). 2 in ROW 1 is already Labeled, so change FLAG= PREVMARKED and L = Label assigned to the already Labeled cell (value 1). Now CR is incremented by 1 (CR =2). The cell marked in CR is 3 (PV [] = {3}).

Pass ii: The cell marked in Row 2 is 3 (AV [] = 3). The adjacent values of 3 are 2, 3 and 4. AVCR [] = {2, 3, 4}. The adjacent value of 3 is 3 according to step 7 i.e AVOR [] = {3}. The AVCR[] values are searched in CR and AVOR[] in CR+1. Those cells are 2 in Row 2 and 3 in Row 1) are marked (Fig 4c). Now CR is incremented by 1 (CR =3). The cell marked in CR is NIL (PV [] = {NIL}). There is no cell marked in Row 3 (PV [] = ∅). Second Pass is Over. Assign L to the corresponding marked cells in the Input Image (Fig 4d). As FLAG is PREVMARKED , LABEL will remain same (LABEL =2).

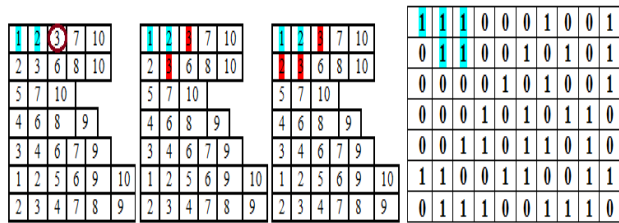


Fig 4: (a) 1st Unmarked Cell (b) Pass II- i (b) Pass II- ii (d) Output of Pass II

PASS III:

Get the first unmarked value (Fig 5a) from the Position Matrix. The unmarked value is 7(found in ROW 1 , so CR=1) PV [] = {1}, FLAG= NOTPREVMARKED according to step 5. L=2 as LABEL=2. Pass i: The adjacent values of 7 are 6, 7 and 8. AVCR [] = {6, 7, 8}. The adjacent value of 7 is 7 according to step 7 i.e AVOR[]={7}. The AVCR[] values are searched in CR and AVOR[] in CR+1 and those cells (7 in Row 1 and NIL in Row 2) are marked (Fig 5b). Now CR is incremented by 1 (CR =2). The cell marked in CR is NIL (PV [] = {NIL}).

There is no cell marked in Row 2 (PV[] = ∅). Third Pass is Over. Assign L to the corresponding marked

cells in the Input Image (Fig 5c). As FLAG is NOTPREVMARKED , LABEL is incremented by one. (LABEL =3).

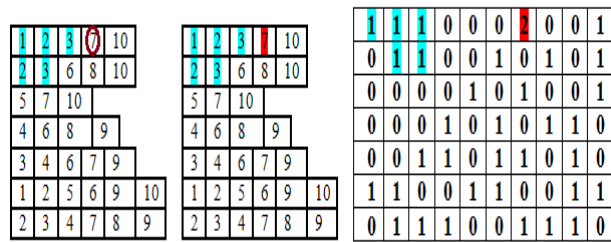


Fig 5: (a) 1st Unmarked Cell (b) Pass III- i (c) Output of Pass III

PASS IV :

Get the first unmarked value (Fig 6a) from the Position Matrix. The unmarked value is 10(found in ROW 1 , so CR=1) PV [] = {10}, FLAG= NOTPREVMARKED according to step 5. L=3 as LABEL=3. Pass i: The adjacent values of 10 are 9, and 10. AVCR [] = {9, 10}. The adjacent value of 10 is 10 according to step 7 i.e AVOR[]={10}. The AVCR[] values are searched in CR and AVOR[] in CR+1 and those cells (10 in Row 1 and 10 in Row 2) are marked (Fig 6b). Now CR is incremented by 1 (CR =2). The cell marked in CR is 10 (PV [] = {10}).

Pass ii : The cell marked in Row 2 is 10. The adjacent values of 10 are 9, and 10. AVCR [] = {9, 10}. The adjacent value of 10 is 10 according to step 7 i.e AVOR[]={10}. The AVCR[] values are searched in CR and AVOR[] in CR-1, CR+1 and those cells (10 in Row 1 (already marked in pass IV) , 10 in Row 2 (already marked in pass I) and 10 in Row 3) are marked (Fig 6b). Now CR is incremented by 1 (CR =3). The cell marked in CR is 10 (PV [] = {10}). Pass iii: The cell marked in Row 3 is 10. The adjacent values of 10 are 9, and 10. AVCR [] = {9, 10}. The adjacent value of 10 is 10 according to step 7 i.e AVOR[]={10}. The AVCR[] values are searched in CR and AVOR[] in CR-1, CR+1 and marked. CR is incremented by 1 (CR =4). The cell marked in CR is NIL (PV [] = {}). There is no cell marked in Row 4 (PV[] = ∅). Fourth Pass is Over. Assign L to the corresponding marked cells in the Input Image (Fig 5c). As FLAG is NOTPREVMARKED , LABEL is incremented by one. (LABEL =4).

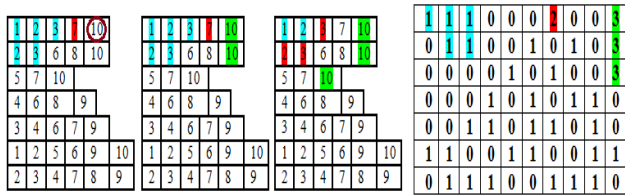


Fig 6: (a) 1st Unmarked Cell (b) Pass IV- i (b) Pass IV- ii (d) Output of Pass IV

PASS V:

Get the first unmarked value (Fig 7a) from the Position Matrix. The unmarked value is 6(found in ROW 2 , so CR=2) PV [] = {7}, FLAG= NOTPREVMARKED according to step 5. L=4 as LABEL=4.Pass i: The adjacent values of 6 are 5, 6 and 7. AVCR [] = {5, 6, 7}. The adjacent value of 6 is 6 according to step 7 i.e AVOR[]={4}.The AVCR[] values are searched in CR and AVOR[] in CR+1 and those cells (6 in Row 2 and NIL in Row 3) are marked (Fig 7b). Now CR is incremented by 1 (CR =3). The cell marked in CR is NIL (PV [] = {NIL}). There is no cell marked in Row 3 (PV [] = ∅).Fifth Pass is Over. Assign L to the corresponding marked cells in the Input Image (Fig 7c). As FLAG is NOTPREVMARKED , LABEL is incremented by one. (LABEL =5).

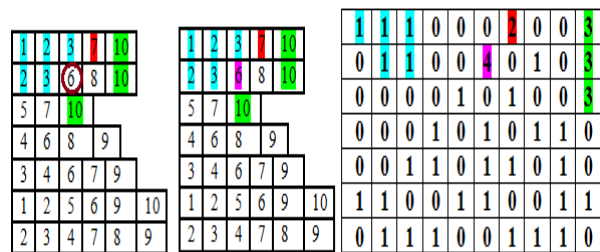


Fig 7: (a) 1st Unmarked Cell (b) Pass V- i c) Output of Pass V

PASS VI:

Get the first unmarked value (Fig 8a) from the Position Matrix. The unmarked value is 5(found in ROW 3, so CR=3) PV [] = {5}, FLAG= NOTPREVMARKED according to step 5. L=6 as LABEL=6.Pass i: The adjacent values of 5 are 4, 5 and 6. AVCR [] = {4, 5, 6}. The adjacent value of 5 is 5 according to step 7 i.e AVOR[]={5}.The AVCR[] values are searched in CR and AVOR[] in CR+1 and those cells (5 in Row 3 and NIL in Row 3) are marked (Fig 9b). Now CR is incremented by 1 (CR =4). The cell marked in CR is NIL (PV [] = {NIL}).

(AV [] = ∅).This Pass is Over. Assign L to the corresponding marked cells in the Input Image (Fig 8c). As FLAG is NOTPREVMARKED , LABEL is incremented by one. (LABEL =6).

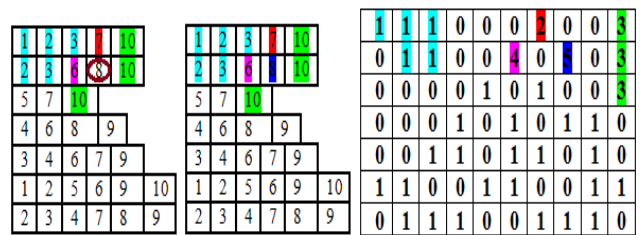


Fig 8: (a) 1st Unmarked Cell (b) Pass VI- i (c) Output of Pass VI

PASS VII:

Get the first unmarked value (Fig 9a) from the Position Matrix. The unmarked value is 8(found in ROW 2, so CR=2) PV [] = {5}, FLAG= NOTPREVMARKED according to step 5. L=5 as LABEL=5.Pass i: The adjacent values of 8 are 7, 8 and 9. AVCR [] = {7, 8, 9}. The adjacent value of 8 is 8 according to step 7 i.e AVOR[]={8}.The AVCR[] values are searched in CR and AVOR[] in CR+1 and those cells (8 in Row 2 and NIL in Row 3) are marked (Fig 8b). Now CR is incremented by 1 (CR =3). The cell marked in CR is NIL (PV [] = {NIL}). There is no cell marked in Row 4 (AV [] = ∅).This Pass is Over. Assign L to the corresponding marked cells in the Input Image (Fig 9c). As FLAG is NOTPREVMARKED , LABEL is incremented by one. (LABEL =7).

There is no cell marked in Row 4 (AV [] = ∅).This Pass is Over. Assign L to the corresponding marked cells in the Input Image (Fig 9c). As FLAG is NOTPREVMARKED , LABEL is incremented by one. (LABEL =7).

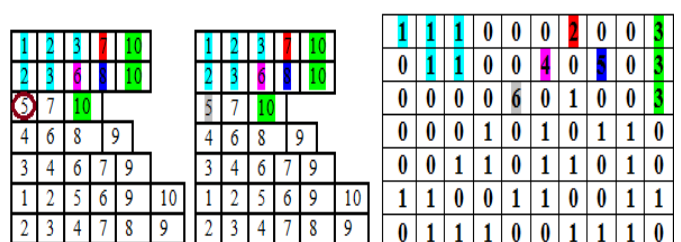


Fig 9: (a) 1st Unmarked Cell (b) Pass VII- i (c) Output of Pass VII

PASS VIII:

Get the first unmarked value (Fig 10a) from the Position Matrix. The unmarked value is 7(found in ROW 3, so CR=3) PV [] = {7}, FLAG= NOTPREVMARKED according to step 5. L=7 as

LABEL=7.Pass i: The adjacent values of 7 are 6, 7 and 8. AVCR [] = {4, 5, 6}. The adjacent value of 7 is 7 according to step 7 i.e AVOR[]={7}.The AVCR[] values are searched in CR and AVOR[] in CR+1 and those cells (7 in Row 3 and NIL in Row 4) are marked (Fig 10b). Now CR is incremented by 1 (CR =4). The cell marked in CR is NIL (PV [] = {NIL}). There is no cell marked in Row 4 (AV [] = \emptyset).Eighth Pass is Over. Assign L to the corresponding marked cells in the Input Image (Fig 10c). As FLAG is NOTPREVMARKED , LABEL is incremented by one. (LABEL =8).

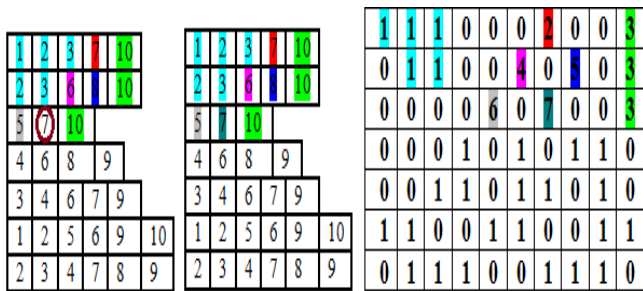


Fig 10 :(a) 1st Unmarked Cell (b) Pass VIII- i (c) Output of Pass VIII

PASS IX:

Get the first unmarked value (Fig 11a) from the Position Matrix. The unmarked value is 4(found in ROW 4 , so CR=4) PV [] = {4}, FLAG= NOTPREVMARKED according to step 5. L=8 as LABEL=8.Pass i: The adjacent values of 4 are 3, 4 and 5. AVCR [] = {3, 4, 5}. The adjacent value of 4 is 4 according to step 7 i.e AVOR[]={4}.The AVCR[] values are searched in CR and AVOR[] in CR+1, CR - 1 and those cells (4 in Row 4 and 4 in Row 5) are marked (Fig 11b). Now CR is incremented by 1 (CR =5). The cell marked in CR is 4 (PV [] = {4}). Pass ii: The cell marked in Row 5 is 4. The adjacent values are 3, 4 and 5. AVCR [] = {3, 4, 5}. The adjacent value of 4 is 4 according to step 7 i.e AVOR[]={4}.The AVCR[] values are searched in CR and AVOR[] in CR-1, CR+1 and those cells (3 in Row 5) are marked (Fig 11c). Now CR is incremented by 1 (CR =6). The cell marked in CR is NIL (PV [] = {NIL}). There is no cell marked in Row 5 (PV [] = \emptyset).This Pass is Over. Assign L to the corresponding marked cells in the Input Image (Fig 11d). As FLAG is NOTPREVMARKED , LABEL is incremented by one. (LABEL =9)

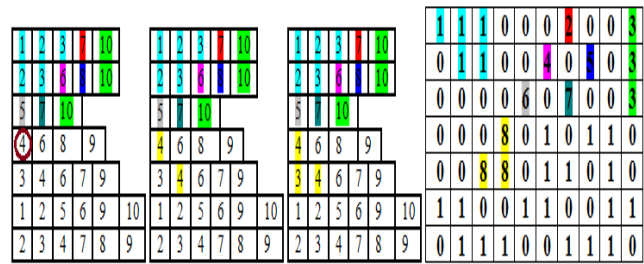


Fig 11: (a) 1st Unmarked Cell (b) Pass IX- i (c) Pass IX- ii (d) Output of Pass IX

PASS X

Get the first unmarked value (Fig 12a) from the Position Matrix. The unmarked value is 6(found in ROW 4 , so CR=4) PV [] = {6}, FLAG= NOTPREVMARKED according to step 5. L=9 as LABEL=9.Pass i: The adjacent values of 6 are 5, 6 and 7. AVCR [] = {5, 6, 7}. The adjacent value of 6 is 6 according to step 7 i.e AVOR[]={6}.The AVCR[] values are searched in CR and AVOR[] in CR+1, CR - 1 and those cells (6 in Row 4 and 6 in Row 5) are marked (Fig 12b). Now CR is incremented by 1 (CR =5). The cell marked in CR is 6 (PV [] = {6}). Pass ii: The cell marked in Row 5 is 6. The adjacent values are 5, 6 and 7. AVCR [] = {5, 6, 7}. The adjacent value of 6 is 6 according to step 7 i.e AVOR[]={6}.The AVCR[] values are searched in CR and AVOR[] in CR-1, CR+1 and those cells (7 in Row 5 and 6 in Row 6) are marked (Fig 12c). Now CR is incremented by 1 (CR =6). The cell marked in CR is 6 (PV [] = {6}). Pass iii: The cell marked in Row 6 is 6. The adjacent values are 5, 6 and 7. AVCR [] = {5, 6, 7}. The adjacent value of 6 is 6 according to step 7 i.e AVOR[]={6}.The AVCR[] values are searched in CR and AVOR[] in CR-1, CR+1 and those cells (5 in Row 6) are marked (Fig 12d). Now CR is incremented by 1 (CR =7). The cell marked in CR is NIL (PV [] = {NIL}). There is no cell marked in Row 7 (PV [] = \emptyset).This Pass is Over. Assign L to the corresponding marked cells in the Input Image (Fig 12e). As FLAG is NOTPREVMARKED , LABEL is incremented by one. (LABEL =10).



Fig 12: (a) (b) (c)
(a) 1st Unmarked Cell (b) Pass X- i (c) Pass X- ii



Fig 12 : (d) PASS X-iii (e) Output of Pass IX

PASS XI:

Get the first unmarked value (Fig 13a) from the Position Matrix. The unmarked value is 8(found in ROW 4 , so CR=4) PV [] = {8}, FLAG= NOTPREVMARKED according to step 5. L=10 as LABEL=10.Pass i: The adjacent values of 8 are 7, 8 and 9. AVCR [] = {7, 8, 9}. The adjacent value of 8 is 8 according to step 7 i.e AVOR[]={8}.The AVCR[] values are searched in CR and AVOR[] in CR+1, CR - 1 and those cells (8 in Row 4 and 9 in Row 4) are marked (Fig 13b). Now CR is incremented by 1 (CR =5). The cell marked in CR is 6 (PV [] = {NIL}).

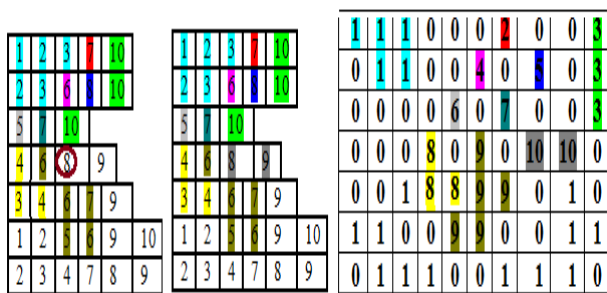


Fig 13 : (a) (b) (c)
(a) 1st Unmarked Cell (b) Pass XI- i (c) Output of Pass XI

There is no cell marked in Row 7 (PV[] = ∅).This Pass is Over. Assign L to the corresponding marked cells in the Input Image (Fig 13c). As FLAG is NOTPREVMARKED , LABEL is incremented by one. (LABEL =11).

PASS XII:

Get the first unmarked value (Fig 14a) from the Position Matrix. The unmarked value is 9(found in ROW 5 , so CR=5) PV [] = {9}, FLAG= NOTPREVMARKED according to step 5. L=11 as LABEL=11.Pass i: The adjacent values of 9 are 8, 9 and 10. AVCR [] = {8, 9, 10}. The adjacent value of 9 is 9 according to step 7 i.e AVOR[]={6}.The AVCR[] values are searched in CR and AVOR[] in CR+1, CR - 1 and those cells (9 in Row 4 , 9 in Row 5, 9 in Row 6) are marked (Fig 14b). 9 in ROW 4 is already Labeled, so , change FLAG= PREVMARKED and L = Label assigned to the already Labeled cell (value 10). Now CR is incremented by 1 (CR =6). The cell marked in CR are 9 and 10 (PV [] = {9,10}). Pass ii : The cell marked in Row 6 is 9 and 10. The adjacent values are 8,9, and 10. AVCR [] = {8, 9, 10}. The adjacent value of 9, 10 are 9 and 10 according to step 7 i.e AVOR[]={9,10}.The AVCR[] values are searched in CR and AVOR[] in CR-1, CR+1 and those cells (10 in Row 6 and 9 in Row 7) are marked (Fig 14c). Now CR is incremented by 1 (CR =7). The cell marked in CR is 9 (PV [] = {9}). Pass iii : The cell marked in Row 7 is 9. The adjacent values are 8, 9 and 10. AVCR [] = {8, 9, 10}. The adjacent value of 9 is 9 according to step 7 i.e AVOR[]={9}.

The AVCR[] values are searched in CR and AVOR[] in CR-1 (last row) and those cells (8 in Row 7 are marked (Fig 14d). Now CR is incremented by 1 (CR =8). CR > LastRow. This Pass is Over. Assign L to the corresponding marked cells in the Input Image (Fig 14e). As FLAG is PREVMARKED , LABEL will remain same (LABEL =11).

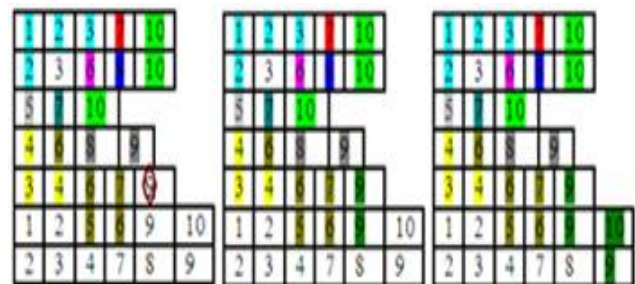


Fig 14: (a) (b) (c)
(a) 1st Unmarked Cell (b) Pass XII- i (c) Pass XII- ii



Fig 14 : d) PASS XII-iii (e) Output of Pass XII

PASS XIII:

Get the first unmarked value (Fig 15a) from the Position Matrix. The unmarked value is 1(found in ROW 6, so CR=6) PV [] = {1}, FLAG= NOTPREVMARKED according to step 5. L=11 as LABEL=11.Pass i: The adjacent values of 1 are 1 and 2. AVCR [] = {1, 2}. The adjacent value of 1 is 1 according to step 7 i.e AVOR[]={1}.The AVCR[] values are searched in CR and AVOR[] in CR+1, CR - 1 and those cells (1 in Row 6 , 2 in Row 6) are marked (Fig 15b). Now CR is incremented by 1 (CR =7). The cell marked in CR is NIL and 10 (PV [] = {NIL}). There is no cell marked in Row 7 (PV [] = ∅).This Pass is Over. Assign L to the corresponding marked cells in the Input Image As FLAG is NOTPREVMARKED , LABEL is incremented by one. (LABEL =12).

PASS XIV:

Get the first unmarked value (Fig 15c) from the Position Matrix. The unmarked value is 2(found in ROW 7, so CR=7) PV [] = {1}, FLAG= NOTPREVMARKED according to step 5. L=12 as LABEL=12.Pass i: The adjacent values of 1 are 1, 2. AVCR [] = {1, 2}. The adjacent value of 1 is 1 according to step 7 i.e AVOR[]={1}.The AVCR[] values are searched in CR and AVOR[] in CR -1 and those cells (1,2 in Row) are marked (Fig 15d). 2 in ROW 6 is already Labeled , so , change FLAG= PREVMARKED and L = Label assigned to the already Labeled cell (value 11). Now CR is incremented by 1 (CR =8). CR > LastRow. This Pass is over. Assign L to the corresponding marked cells in the Input Image .As FLAG is PREVMARKED, LABEL will remain same (LABEL =12).

PASS XV:

Get the first unmarked value (Fig 15e) from the Position Matrix. The unmarked value is 4 (found in ROW 7, so CR=7) PV [] = {4}, FLAG= NOTPREVMARKED according to step 5. L=12 as LABEL=12.Pass i: The adjacent values of 4 are 3, 4 and 5. AVCR [] = {3, 4, 5}. The adjacent value of 4 is 4 according to step 7 i.e AVOR[]={4}.The AVCR[] values are searched in CR and AVOR[] in CR -1 and those cells (3 in Row 7 and 4 in Row 7) are marked (Fig 15f). 3 in ROW 7 is already Labeled , so , change FLAG= PREVMARKED and L = Label assigned to the already Labeled cell (value 11). Now CR is incremented by 1 (CR =8). CR > LastRow. This Pass is Over. Assign L to the corresponding marked cells in the Input Image (Fig 15g). As FLAG is PREVMARKED , LABEL will remain same (LABEL =12).

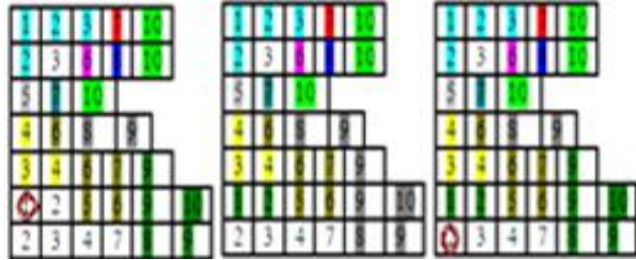


Fig 15: (a) 1st Unmarked Cell (b)Pass XIII (c) 1st Unmarked cell

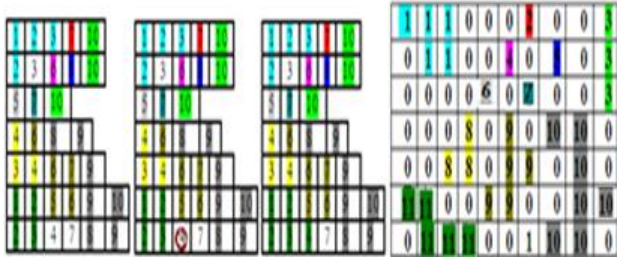


Fig 15: (d)PASS XV (e) 1st Unmarked cell (f)PASS XVI (g)o/p of PASS XVI

PASS XVI:

Get the first unmarked value (Fig 16a) from the Position Matrix. The unmarked value is 7 (found in ROW 7 , so CR=7) PV [] = {7}, FLAG= NOTPREVMARKED according to step 5. L=12 as LABEL=12.Pass i: The adjacent values of 7 are 6, 7 and 8. AVCR [] = {6, 7, 8}. The adjacent value of 7 is 7 according to step 7 i.e AVOR[]={7}.The AVCR[] values are searched in CR and AVOR[] in CR -1 and

those cells (7 in Row 7 and 7 in Row 7) are marked (Fig 16b). 7 in ROW 7 is already Labeled , so , change FLAG= PREVMARKED and L = Label assigned to the already Labeled cell (value 10). Now CR is incremented by 1 (CR =8). CR > LastRow. This Pass is Over. Assign L to the corresponding marked cells in the Input Image (Fig 16c). As FLAG is PREVMARKED , LABEL is will remain same (LABEL =12).

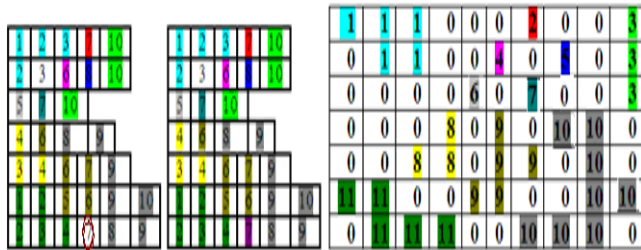


Fig 16 : (a) 1st Unmarked Cell b)Pass XVI - i c) O/P Image

No more unmarked cells are found. So, Iterations are over and Total_No_Components= 11 (LABEL – 1). There are 11components found and those components are labeled as 1 to 11.

III. EXPERIMENTAL RESULTS

The experimentation of the algorithm is implemented in Matlab Tool and was carried out on the ICDAR data set consisting of 250 different images. The images are converted in to binary image by applying otsu’s threshold method [8]. Some of the images taken for the experiment are shown in Fig 17. The experimental results of Fig 18 is shown in Table I .The experimental results in this research confirm that the new proposed method labels the connected component and gives the number of components present in the binary images with 100% accuracy.

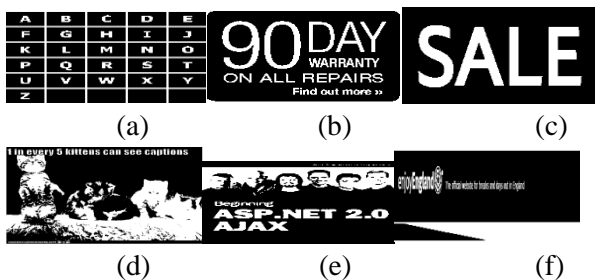


Fig 17: Sample Images

TABLE I.

EVALUATED NUMBER OF CONNECTED COMPONENT

Image	Size	No. of Connected Component Found
Fig 17a	142 x 178	27
Fig 17b	125 x 195	36
Fig 17c	125 x 300	4
Fig 17d	359 x 499	499
Fig 17e	297 x 275	72
Fig 17f	126 x 900	67

IV. CONCLUSION

This paper projected a new 4 way positional connected component labeling algorithm to label the connected components and to report the number of components present in binary image. The proposed technique is an important stage for the object extraction method. Experiments are conducted by applying proper thresholding technique on various images taken from ICDAR datasets and found that the outcome of the algorithm is 100%.

V. REFERENCES

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