GRID LEVEL DOORSTEP ASSESSMENTS FOR IMAGE APPLIANCE

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Abstract: This paper presents a method for calculating a comprehensive Grid Level Doorstep for different image appliances. Objective of the proposed method is to develop a universal Doorstep for all type of image based application areas like medical science, biometric science and object identification, which are conquered by detection of existing number of objects in the images. The anticipated process use a grid based cellular automata approach which takes input of related image and target nearby the entire possible pixels grid whose intensity is better than other grids. The searching of intensity is continuing up to specified grid level and estimate a vector by using selective intensity of all the pixels. The vector is use to finalized a universal Doorstep for all the pixels of image. While image processing the Doorstep consider only those pixels whose intensity is better than the estimated Doorstep value. The proposed Doorstep is useful for performing various image appliances like image segmentation, edge detection, improving quality and so on. The proportional study expresses effectiveness of projected technique.

Indec Trems: Grid, Doorstep, Intensity, Automata, Blur.

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1. INTRODUCTION

Image is a group of pixels and all the pixels are represents in the form of cell or grid. All the pixels in an image have various neighbour pixels and all the neighbour pixels classified in different levels. All the outer pixels called first level, the outer neighbour pixels of first level called second level and so on. All the pixels in an image have a numeric value according to their properties. This numeric value called intensity of a pixel. The greater intensity value of a pixel considers better intensity. A 2-D image consist of M * N grids. Where M represents number of horizontal grids and N represents number of vertical grids and M * N represents total number of grids use to represents pixels of an image [1]. A pixel of an image maximum eight neighbour pixels at first level, maximum 2*8=16 pixels at second level, maximum 3*8=24 pixels at third level and so on. The maximum number of neighbour pixels are either M*8 or N*8 at M^{th} or N^{th} level [2]. Figure 1 shows different level of grid structure of a pixel for any image. L1 represents first level of grid, L2 represents second level of grid, and L3 represents third level of grid and so on. The proposed method works on such levels to implement targeted Doorstep for image appliance. Image appliance like image segmentation means detection of objects; edge detection means a boundary or an area where intensity value changed and improving the quality of image [3]. The excellence of besieged image objects, edges, region etc are measured by using image properties like image pixels concentration, permanence of pixels, disparity and brightness of pixels. The excellence of pixels can be enhanced with the help the neighbour pixels excellence. All the nearby pixels up to desired radius pixels or neighbour pixels are participating to increase excellence of resultant image [4]. Consequently, the primary intention of improving quality is to determine and modify all the features of resultant image to make it more relevant to desired and a defined target. The proposed Doorstep is applicable to implements such types of image applications. The Cellular Automata (CA) is a contemporary method used to generate new results by using previous results and current result. CA use registers to store previous and current result while calculating new result. CA use registers to store previous and current result while calculating new result. The Cellular automata are very useful in all the grid based applications. The grid based applications are extended to other fields like computer architecture, language recognition, image processing, simulation, biological models, cryptography and many other fields. The concept of CA was initiated J. Von Neumann and Stan Ulam in the year 1940. Von Neumann has been shown that CA can be universal standard [5].

M*N	N →								
M ↓	↖								↗
		R3	R3	R3	R3	R3	R3	R3	
		R3	R3	R3	R3	R3	R3	R3	
		R3	R3	L1	L1	L1	R3	R3	
		R3	R3	L1	P	L1	R3	R3	
		R3	R3	L1	L1	L1	R3	R3	
		R3	R3	R3	R3	R3	R3	R3	
		R3	R3	R3	R3	R3	R3	R3	
	↙								↘

Fig. 1 Grid level structure

The vital component of a CA is the cell or grid. A cell is a special kind of a memory element that stores words and states. It consists of a normal lattice (grid) of cells, which is having finite number of states, such as "On" and "Off". These entire grids have a finite number of dimensions. All the set of cell or grid is consider as a neighbourhood of the cell. The neighbourhood of a cell can be defined as the set of cells or pair of cells which have distance of 2 or less from the cell. At time t=0 each cell is assigning a state which is called initial state. At next time a new production is formed according to a few of fixed rules that determine the new state for each cell on the basis of the current or previous state of the cell [6]. The remaining sections of paper are organized as follows. The various types of cellular automata regulations or rules are defined in section II. The proposed framework for gird constructions is representing in section III, The universal Doorstep construction is representing in section IV, experimental results and proportional study is representing in section V and concluding remarks given in section VI.

2. CELLULAR AUTOMATA REGULATIONS

All the cells in cellular Automata arranged in a spatial web form is called lattice. These entire lattices represent a static state. To introduce dynamic state into the system, we have to add some regulations or rules. These rules define the next state of each cell. In cellular automata next state of a cell depend on the neighbourhood of the cell. The state of the cantered cell at a time step (t+1) will be concluded from the states of cells within its neighbourhood at time step t. A specified rule of CA is introduced at time step (t+1) and the states of current cell are simplified synchronously in time steps for all cells. The state of cell may vary between values 0 to n for an n-state CA. So, value o or 1 is the possible state of a cell for *2*-state CA. Hence the relationship between states at different time stamp can be expressed as [7]:

$$S_n(t+1) = f(S_c(t) + S_{neigh}(c)(t))$$

Where S_n is the new state at time t+1, S_c is the state of current cell, $S_{neigh}(i)$ is the state of neighbour cells at time t and f is the transition function that new state of the current cell.

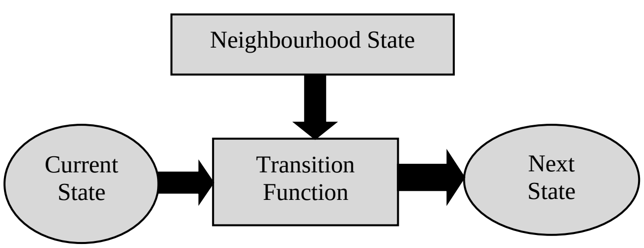


Fig.2 Cellular Automata model

The cellular automata model is shown in the figure 2, which changes their state synchronously, according to a local update rule. The applied rule identifies the new state for all cells of source data and the new state is based on the old states and neighbours state. The CA's rule finalise the state for each cell after number of iterations. The CA's rules are classified in three ways according to their dimensions. They can be 1D CA, 2D CA, 3D CA etc.

2.1. One-Dimension Cellular Automata (1D CA)

A one-dimensional cellular automaton is one of the easiest models of cellular automata. The possible states of cellular automata outputs for each cell is either "on" or "off" (0 or 1), and CA's rules are depend only on nearest neighbour states of cell. As a result, the evolution of an elementary cellular automaton can be described by a table that represent the initial state a given cell with next state of cell based on the value of the left cell, the value the cell itself, and the value of the right cell. If a given cell has three neighbouring cells than there are $2*2*2=2^3=8$ possible binary states and there are a total of $2^8=256$ elementary cellular automata. All these 256 elementary cellular automata rules can be indexed with an 8-bit binary number.

2.2. Two-Dimension Cellular Automata (2D CA)

Two-Dimensional (2D) cellular automata are to be considered more comprehensively than 1D CA with straightforward primary conditions. There were various categories of cellular automata considered, the 5-cell neighbourhood CA was considered by John von Neumann in 1952; the 9-cell neighbourhood CA was considered Edward Moore in 1962. (Both are also common in finite difference approximations in numerical analysis). Different characterizations of neighbourhoods are promising in 2D space. Various two dimensional cellular automata definitions are defined; some common definitions are as follow [8].

2.2.1 Outer cellular automata, eight cells: The cells outside from each cell are called the outer cellular automata. While counting the total number of neighbour cells of cantered cell only the next layer or cells up to one radius of cell is consider. Hence in outer 2D CA the total number of neighbour cells is 5 cells.

2.2.2 Outer totality cellular automata, nine cells: The outer totality cellular automata are an enlargement of the outer cellular automata including centred cell itself. In this case, while counting total number of neighbour cells of a cell consider only the next layer or up to one radius of cell. Hence in outer totality 2D CA the total number of neighbour cells include itself is 9 cells.

2.2.3 Radius or layer based cellular automata: Radius based cellular automata may consider neighbour cells up to nth level including or not including centred cell. The value of n is depends on the current object. Total number of neighbour cells is counting with the help of adjacent cells. If the current object is exist up to second layer or two cell of radius than the total neighbour of cells including cantered cell is 25 or excluding itself is 24 cells. The figure 3 shown different types of 2D cellular automata. The red or yellow cell is the centre cell and the green cells are the outer neighbourhood cells.

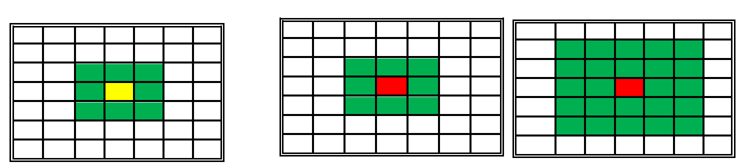


Fig.3 Types of Cellular automata
(a) OCA (b) OTCA (c) RBCA

One of the prominent paradigms of 2D Cellular Automata is Game of Life. This was first practically invented example of 2D CA which was developed by John Conway. He used 2D grid of squares and each square of grid can be alive or dead. The alive and dead cells are also known as black and white cells. Alive cells can become dead and dead cells can become alive depending on the neighbours. Each cell has 8 alive or dead neighbours, 4 adjacent diagonally and 4 adjacent orthogonally. So Game of Life is based on OTCA neighbourhoods. The OTCA method converts the source file into binary matrix. Each cell of binary matrix may contain either 0 or 1 value. The alive or black cell represented by value 1 and white or dead cell represented by value 0 [9]. The OTCA rule of life is defined as:

a. The centred cell may have 1 to 8 alive or dead neighbour cells.
b. If an alive neighbour cells are less than 4 then the centred cell goes into died state, -- **isolation**
c. If an alive neighbour cells are 7 or 8 than the centred cell goes to dead state, – **overloading**
d. If an alive neighbour cells are either 4 or 6 than centred cell goes to alive state, -- **pleasure**
e. If centred cell in dead state and has only 5 alive neighbours, it goes to alive state, -- **facsimile**. Otherwise the centred cell stays into dead state.

3. GRID CONSTRUCTION

An image has large number of pixels and every pixel represents in the form of grid. Every grid contains intensity value of a pixel. Every pixel has number of neighbour pixels at various levels. The primary objective of grid construction is to create a cluster of grids. The cluster may contain all nearest possible grids, which are having intensity of an object. The cluster of grids plays an important role for calculation of common Doorstep. Grid cluster calculated by analysis of an image at various levels [10]. The following steps help us for determine the required grids.

3.1. Image Acquirement

An image may be in various format and various types i.e. various formats like jpeg, bmp, rtf, etc and various types like RGB, Black and White and Gray images [11]. The proposed method works on any type of images and any format.

3.2. Blur Confiscate

Blur in image has special uniqueness characteristics that added synthetically at the time of image creation or during any updating [12]. A blur can decrease quality of an image, so it requires smoothing for better image appliance. The second order differentiation filters used to smooth blurred image. To reduce the blurred effect, the image smoothed by the following Gaussian filter [13].

$$P(i,j) = e^{-\frac{i^2+j^2}{2\sigma^2}}$$

Where $P(i,j)$ is blurred pixel and σ determines the degree of smoothing and masks size increases with σ.
The output of the Gaussian operator $H(i,j)$ is obtained by the convolution operation [14].

$$H(i,j) = \nabla^2[G(i,j) * P(i,j)] = \nabla^2 G(i,j) * \nabla^2 P(i,j)$$

Where

$$\nabla^2 G(i,j) = \left(\frac{i^2+j^2-2\sigma^2}{\sigma^4}\right)^{-(i^2+j^2)/2\sigma^2}$$

The filter is applying on all pixels of blurred image and get enhanced image. Figure 5 shows blurred and enhanced image.

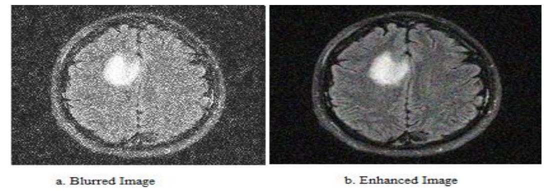


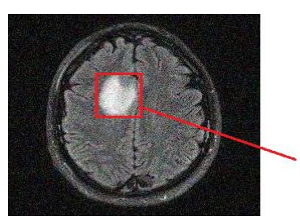
Fig. 5 Blurred and Enhanced image

3.3. Transformation

All the images have number of pixels and each pixel has a fixed numerical value called intensity. In this step image should translated into form of rows and columns called intensity image. These rows and columns constructs number of girds and each grid contains the numerical value of a pixel [15]. The imToMatrix() algorithm is use to convert image to matrix [16].

```
imToMatrix()
Step 1: im=imread('input image')
Step 2: [x,y,z]=size(im)
Step 3: if (z==3)
            mat = im2gray(im)
else
      for(i=0 to m)
          for(j=0 to n)
             mat(i,j)=im(i,j)
```

Consider the enhanced image given in figure 4 and an area surrounded by a square, whose intensity image is show in figure 4.



234	244	212	176	232
243	133	58	34	214
233	54	65	36	255
213	53	74	176	235
200	65	45	187	231
230	198	243	211	168

Fig. 4 Enhanced image and corresponding intensity image

3.4. Cluster Formation

All the pixels in an image are scattered in M * N grids and all pixels are divided in sub matrices [17]. A sub matrix is belongs an object of image and sub matrix has similar intensity. The objective of this step is to construct a sub matrices or clusters [18]. To construct a cluster arbitrary select a pixel $P_{i,j}$ of an image $I_{M,N}$. The selected pixel may have number of neighbour pixels at different grid level. Cluster of first level constructed by considering pixels only first level grid. First level cluster calculated by equation 1 [19], where GLF is first level cluster and P is arbitrary selected pixel.

$$GLF_{i,j} = \sum_{k=i-1}^{i+1}\sum_{l=j-1}^{j+1} P_{l,k} - P_{i,j} \quad (1)$$

Cluster of second level consider pixels only second level grid. Second level grid constructed by equation 2 [20], where GLS is second level cluster and P is arbitrary selected pixel.

$$GLS_{i,j} = \sum_{k=i-2}^{i+2}\sum_{l=j-2}^{j+2} P_{k,l} - \sum_{k=i-1}^{i+1}\sum_{l=j-1}^{j+1} P_{k,l} - P_{i,} \quad (2)$$

Third level cluster include pixels only third level grid. Cluster of third level constructed by equation 3, where GLT is third level cluster and P is arbitrary selected pixel.

$$GLT_{i,j} = \sum_{k=i-3}^{i+3}\sum_{l=j-3}^{j+3} P_{k,l} - \sum_{k=i-2}^{i+2}\sum_{l=j-2}^{j+2} P_{k,l} - \sum_{k=i-1}^{i+1}\sum_{l=j-1}^{j+1} P_{k,l} - P_{i,j} \quad (3)$$

Consequently cluster of n^{th} level include pixels only n^{th} level grid. Custer of n^{th} level constructed by algorithm nLevelCluster(Image I, int i, int j, int n), where GLN is n^{th} level cluster and $P_{i,j}$ is an arbitrary pixel of passing image $I_{i,j}$.

```
Int[] nLevelCluster(Image I, int i, int j, int n)
    Step 1: Set k=i-n+1;
            Set p=0;
    Step 2: For (l=j-n+1 to j+n-1)
            GLNp=Ik,l;
            P++;
    Step 3: Set l=j-n+1;
    Step 4: For (k=i-n+2 to j+n-2)
            GLNp=Ik,l;
            P++;
    Step 5: Set l=j+n-1;
    Step 6: For (k=i-n+2 to j+n-2)
            GLNp=Ik,l;
            P++;
    Step 7: Set k=i+n-1;
    Step 8: For (l=j-n+1 to j+n-1)
            GLNp=Ik,l;
            P++;
    Step 9: return GLN;
```

3.5. Grid Erection

All the clusters contain different or similar numerical value (Intensity value) of pixels. The final cluster that contains only pixels according to the particular application and the entire pixel having equal or high intensity values as compare to average or mean intensity value. The final cluster plays an important role for finalized Doorstep. Let GC_i is the grid cluster of each level, AI is the average intensity value of each level and FC is the final cluster. The mean of cluster calculate by equation 4 and final cluster by equation 5.

$$AI = Avg(GC_i) \quad (4)$$

$$FC_i = GC_i(\, if I_{i,j} > AI) \quad (5)$$

The principle process of grid construction of the entire pixels represents by figure 6.

The following meanFinal(Image I, int i, int j) algorithm is use to construct final cluster, that will be used to decided final doorstep.

```
// Read input image I_R,C and arbitrary pixel P_i,j
meanFinal(Image I, int i, int j)
Step 1: [R,C]=size(I); // size method return number of rows and columns of an image.
Step 2: For (n=1 to n<=R OR n<=C)
        Int Cluster[]=nLevelCluster(I, i, j, n)
Step 3: TN=0
Step 4: For (k=0 to k<R*C)
        TN=TN+Cluster_k
Step 5: AI=TN/(R*C)
Step 6: l=0
Step 7: For (k=0 to k<R*C)
        If(Clusetr_k>AI)
        FC_l=Cluster_k;
        l++
```

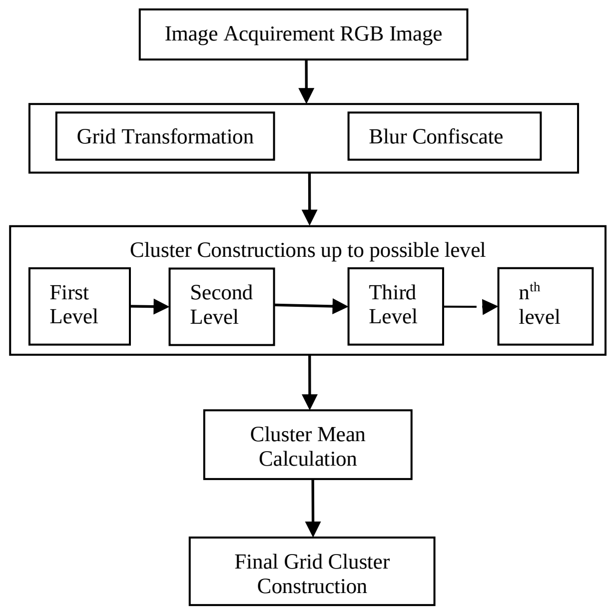


Fig. 6. Grid Construction Principle

4. PROPOSED DOORSTEP ERECTION FOR IMAGE APPLICATION

The proposed Doorstep is a universal entrance for mostly image appliance like segmentation, edge detection, ridge detection, image quality improvement, medical images and so on. The objective of Doorstep creation is to implement image application in easiest manner. To achieve proposed objective a complete study of image is required. Grid structure provides such type of study in valuable approach. Figure 1 shows grid structure of an image. An image may have number of Doorsteps that depends on type of applications. Mostly image applications may use more than one different threshold values to complete specified object. The idea behind the unique Doorstep for all objects of an image is to complete specified task in fastest time and produce unique and efficient results. The grid cluster constructed by the second step is use to achieve desired output. The grid cluster contains different levels of pixels numerical value. These clusters can calculate by using equation1 to equation 3. The final cluster that we shall use for Doorstep erection is constructing by equation 6 to equation 8.

Image $I_{i,j}$ is in the form of two dimensional array and cluster ia in the form of vector or one dimensional array. Therefore, equation 6 convert image two-dimensional array to one-dimensional vector.

$$C_k = I_{i,j} \qquad (6)$$

Where C_k is grid cluster of an image $I_{i,j}$.
Mean value of cluster calculated by equation 7.

$$A = \sum C_i/2 \qquad (7)$$

$$FC_i = C_i\,(\,if\ C_i > A) \qquad (8)$$

All the data of set FC_i plays an important role for find final Doorstep. Let L is number of levels, whose estimated pixels intensity stored in set FC_i. Mean (μ_i) and variance (σ_i) of set FC_i use for calculate Doorstep G. s1 and s2 are background and object classes of an input image. The total pixels in these classes are n1. The total pixels in input image are TN. The mean (μ) and variance (σ^2) of the classes given by:

$$\mu_i = \frac{\sum FC_i}{L_i}$$

$$\sigma_i^{\,2} = \frac{\sum (FC_i - \mu_i)^2}{L_i}$$

$$G = \sum FC_i \sigma_i^2 \qquad (9)$$

G is a global Doorstep for proposed method, which works on any type of images for performing various image appliances. The DOORSTEP G is applicable for all the image applications, which requires one common value. All the various types of image applications like image segmentation, edge extraction, object detection and quality enhancement need a common value for comparing with other values of grid generated from the image. The DOORSTEP G is apply on all the grid values corresponding input image and produces efficient and effective results in less time according to below given equations 10 and 11, where f(x, y) is corresponding grid of input image and output(x, y) is desired result. All the grids current value is changed by either o or 1 by comparing with estimated value G.

$$output\,(x,y) = 0\ if\ f(x,y) \le G \qquad (10)$$

$$output\,(x,y) = 1\ if\ f(x,y) > G \qquad (11)$$

Output of equation 10 and 11 is the desired result of source image. The experiments and comparison shows effectiveness and efficiency of the proposed method.

5. EXPERIMENTAL RRSULTS

The proposed method is applicable in various image related applications like Medical science, Biometric and Object detection. Medical science uses various types of images like X-Ray, CT scan and MRI etc. to resolve different type dieses. The proposed method is experimented on three dataset of MRI images. The below given figure 5 shows experimental steps on MRI image of brain to find exact location and clear image of an area that suffer from tumour. The experimental image1 is input image , image 2 to image 5 are intermediate images showing various internal operations like noise removing, feature extractions, structuring elements, adding and removing pixels. To view more efficiency of the result used contour plot, which display colour and clearer image with axis properties.

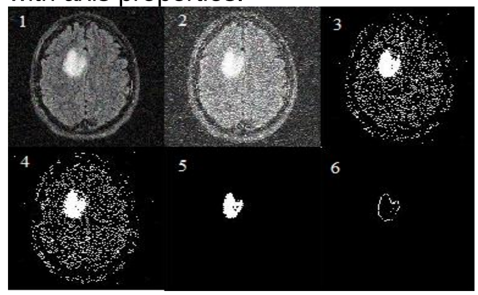


Fig. 7 Experimental results on MRI image

The below given figure 8 represents experimental results on three data set. Data set 1 is gray color MRI image, data set 2 represents true color MRI image and data set 3 represents RGB image. Data set 1 and data set 2 both are different types of MRI images and the proposed method shows exact location and size of tumor.Data set 3 is an ordinary image and proposed method shows number of objects in the image.

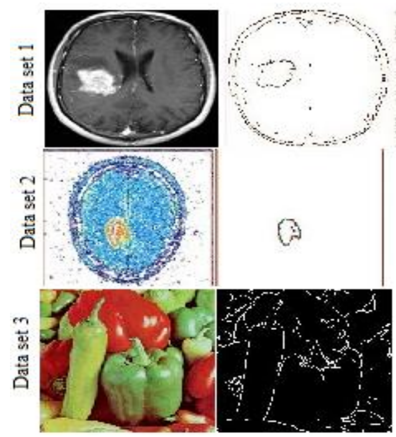


Fig. 8 Experimental results on different data set

The result of proposed method is compared by calculating mean square error (MSE) and peak signal noise ratio (PNSR). MSE and PSNR are the standrad to measure the quality of an image. Lower the MSE and higher the PSNR decides better quality of the image. MSE represents cumulative squared error and PSNR measure peak errors between source and target image. The below given equations 11 and 12 are used to calculate MSE and PSNR value [21].

$$\text{MSE} = \frac{1}{MN}\sum_{i=1}^{M}\sum_{j=1}^{N}(x_{i,j} - X'_{i,j})^2 \qquad (11)$$

$$\text{PSNR} = 10\,log_{10}\frac{(2^n-1)^2}{MSE} = 10\,log_{10}\frac{255^2}{MSE} \qquad (12)$$

Table 1 shows MSE and PSNR values on experimented data and remarks that may be improved, not improved or equal. The improved remark expressed the proposed method provides better results as compared to existing methods. Remarks not improved and equal expressed, there is some areas that will be achieved in future work.

TABLE 1.

Proportional analysis of data sets using MSE and PSNR

Input Data	MSE	PSNR	Remarks
Data Set 1	4.2942	1.8020	Improved
Data Set 2	4.4592	1.6383	Improved
Data Set 3	4.4647	1.6329	Equal

The proposed method useful in biometric devices for verifying and recognizing person based identity like fingers, facial image and iris. The proposed method can help blind persons to identifying number of objects and their types. In this method, first identify objects than by using voice message a blind person can recognize any objects. In same way, a blind person can easily recognize persons by using facial identification method. Automatic vehicles are base on similar method, in this method the system can easily identify objects but unable to identify face.

6. CONCLUSION

This paper present a universal DOORSTEP for image appliances related to medical science, biometric science and object detection. For medical science the DOORSTEP works on MRI, CT scan, X-ray images etc. and find exact location, size and enhanced abnormal area from the input image. This is a unique method, which targets only the region, which has large amount of intensity differences between neighbour pixels and display outlier. Experimental results show robust outlier to detect abnormalities in MRI images. Grid based cellular automata technique is used in the proposed method to increase robustness of the output.

The proposed method is suitable for object detection and identification from ordinary image. Therefore, the future work is to convert identified objects into voice information. The voice information is very useful for the canopy persons to recognize any object.

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