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Lost pixel restoration using pentagonal fuzzy numbers

Dr. M. Kamalam

Department of Mathematics, Shri Shankarlal Sundarbai Shasun Jain College for Women, Chennai

ABSTRACT

The modern technological development has created a scenario in the handling of images, with the digital images becoming almost monopoly. While digital images enjoy a high degree of usage benefits, there are certain challenges faced by the users of these images owing to the inherent problems in capturing and storing them. One such problem that manifests in digital images is the problem of lost pixels. There are many methods used in the literature to address these problems and many used to retrieve or replace the lost pixels in practice. In this paper, we introduce a new method to replace a lost pixels based on pentagonal fuzzy numbers.

Keywords: Pentagonal fuzzy numbers, lost pixels

INTRODUCTION

Digital image processing is an area of research that has attracted the attention of researchers in computer science and mathematics owing to the immediate application value in this area. Researchers have considered many aspects of digital image processing. It is often seen that the digital images suffer quality when the pixels [1] are either lost or undergoes unexpected changes. It has been often realized that some pixels are lost while using a digital image in some stage of its usage, which is very common in satellite images. When pixels are lost, it diminishes the quality of the images, sometimes to undesired proportions. Hence it becomes inevitable that the pixel value of the lost pixels is somehow made up for either by recreation of the original image when it is possible and often by replacing by a good approximation. Many algorithms have been designed by researchers for replacing the lost pixels to a desired level of accuracy [9, 8, 7]. The success of these algorithms lies in not only approximating the lost pixel value to an acceptable nearness to the lost pixel value, but also in the ease with which the algorithm can be employed for computing such values and the effortlessness with which the algorithm can approximate such pixel values. Most of the algorithms used for retrieving the lost pixel value relies on the fact that any pixel will on an average behave only as its neighbouring pixels. So, it is customary that all these algorithms use the pixel value of the pixels in the neighbourhood of the lost pixel.

A digital image is logically organized as rows and columns of elements called pixels that make up the whole image. A pixel is the smallest unit of an image and has several attributes such as the colour, brightness and the background. A pixel is characterized by a number called the pixel value, which is typically an integer in the range 0 to 255. When a pixel is lost, it is to be understood that the integer value associated with that pixel is lost. Hence one has to make up for the lost pixel value by providing either the exact value or an alternate value to the lost pixel value without much of an error. Otherwise, the quality suffered by the image on account of a lost pixel may even be more complicated if an in appropriate value is used to replace it. Hence the problem of lost pixels has to be handled with at most care so that the experience or information that an image will provide will be completely lost.

Fuzzy numbers have dominated several domains of research due to their versatility and immediate solutions they provide. Many fuzzy numbers have been used by the researchers such as the triangular fuzzy numbers [2], trapezoidal fuzzy numbers [4], pentagonal fuzzy numbers [6], octagonal fuzzy numbers [5] and so on. For pixel restoration, fuzzy numbers can be used in combination with a ranking method. In this paper, we use the generalized pentagonal fuzzy numbers to restore a lost pixel value of an image.

We consider the pentagonal fuzzy numbers and consider a number of pentagonal fuzzy numbers to represent the lost pixel value and for the ranking function of the pentagonal fuzzy numbers, we use the ranking function proposed in [3]. For defuzzification, we use the proposed ranking function, by taking the floor in order that the rank represents a pixel value.

PIXEL RESTORATION METHOD

We assume that the lost pixel is X and is at the centre of the following table, which is part of the pixelate of the image. For the restoration process, we consider the pentagonal fuzzy numbers,$\tilde{A}$= (g, h, i, l, m), $\tilde{B}$ = (g, l, p, h, q), $\tilde{C}$ = (i,m, r, h, q) and$\tilde{D}$= (p, q, r, l, m). We then rank these fuzzy numbers as prescribed in [3. We then find the fuzzy number with minimum amongst the ranks and choose it to represent the lost pixel value. The number is assumed to have been defuzzified by the raking functions considered by taking the floor value of the rank, where necessary to arrive at a value between 0 and 255.

a	*b*	*c*	*D*	*e*
f	*g*	*h*	*I*	*j*
k	*l*	***X***	*M*	*n*
0	*p*	*q*	*R*	*s*
t	*u*	*v*	*W*	*y*

We illustrate the above method with the aid of an example. Consider the following pixel matrix of part of an image which contains a lost pixel. We shall retrieve the lost pixel value using the method suggested.

122	130	138	139	134	136	126	144	150	156
125	132	138	145	140	140	130	140	152	162
127	133	142	145	146	141	134	147	154	158
135	134	147	149	***X***	142	140	143	149	153
137	140	151	152	148	152	143	147	154	156
142	144	149	160	154	159	148	154	162	168
146	145	147	155	158	162	156	158	169	171
150	149	155	162	165	167	161	167	179	182
152	158	164	173	177	179	182	188	196	208
155	160	171	177	183	180	185	193	201	211

Table 1

We first form the four pentagonal fuzzy numbers $\tilde{A}$= (g, h, i, l, m), $\tilde{B}$ = (g, l, p, h, q), $\tilde{C}$ = (i, m, r, h, q) and $\tilde{D}$ = (p, q, r, l, m) from the following submatrix of the above matrix.

145	146	141
149	***X***	142
152	148	152

The pentagonal fuzzy numbers considered from Table 1 are, $\tilde{A}$= (145, 146, 141, 149, 142), $\tilde{B}$ = (145, 149, 152, 146,148), $\tilde{C}$ = (141, 142, 152, 146, 148) and $\tilde{D}$ = (152, 148,152, 149, 142). Following the ranking method suggested, we obtain,$R(\tilde{A})$ = 144, $R(\tilde{B})$ = 149, $R(C)$ = 147 and $R(\tilde{D})$ =149. The maximum of these ranks is 149.1929, corresponding to the fuzzy number $\tilde{D}$. Defuzzifying, we get the value of $\boldsymbol{X}$ as 149, taking the floor.

CONCLUSION

The above method is a simple method and more pentagonal fuzzy numbers can be considered than the ones used in the suggested method. Using a greater number of fuzzy sets will improve the reliability of the fuzzification-defuzzification process. We see that retrieved valueof ***X***in the illustration is more like the values in the neighbourhood of the lost pixel value ***X***.

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