Digital Radiation image

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Abstract

This work introduces a new way for data visualization. Its name is " Digital Application name' Image". Normal digital image is created by digital camera or digital scanner but digital application name image is created by measurements of monitoring data. This work uses the data which is measured by radiation monitoring station and classifies it using fuzzy logic rules to create digital radiation image. The main unique advantage of digital radiation image is that it expresses thousands of measurements in a very clear form through only one picture while the maximum number of measurements does not exceed 100 with other conventional visualization methods. This feature gives a facility to view one year of all recorded measurements in only one photo. This picture helps the user to observe the behavior of thousands of measurements in few minutes instead of spending few hours for reviewing hundreds of charts for the same measurements.

Keywords: *Data visualization, Digital image processing, Fuzzy Logic, Digital Measurements Image, Digital Radiation Image.*

1. Introduction

An image may be defined [1] as a two-dimensional function, f(x,y) , where x and y are spatial (plane) coordinates and the amplitude of f at any pair of coordinates (x,y) is called intensity of the image at that point. The term gray level is used often to refer to the intensity of the monochrome images. Color images are formed by a combination of individual 2-D images such as RGB color system, a color image consists of three (red, green, and blue) individual component images. So converting such an image to digital form requires that the coordinates, as well as the amplitude, be digitized. Digitizing the coordinate values is called sampling; digitizing the amplitude values is called quantization. Thus when x,y and the amplitude values of f are all finite, discrete quantities. We call the image a digital image as shown in figure 1 for digital representation for monochrome image and figure 2 for digital representation of RGB color system image.

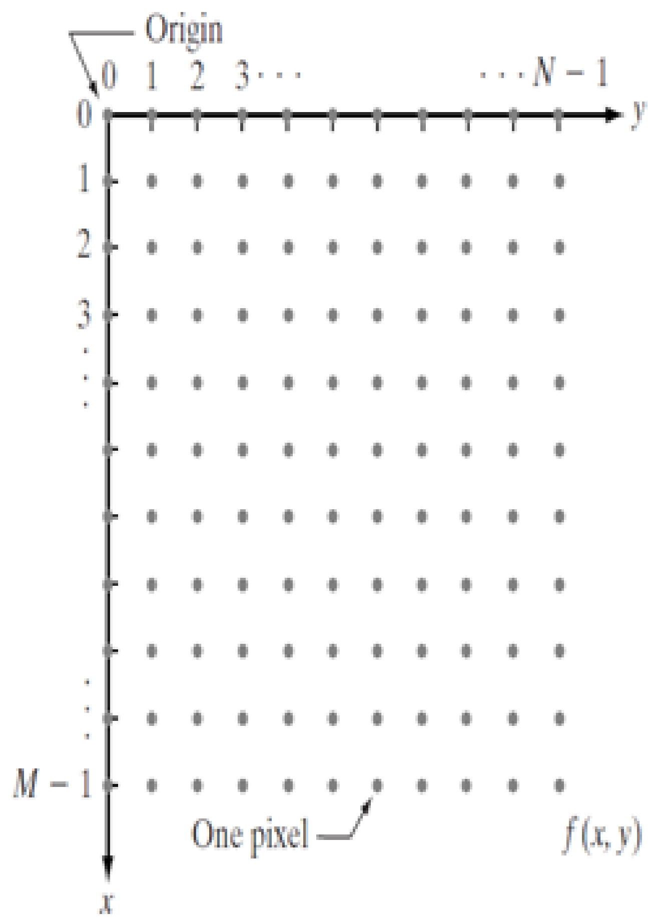

Fig. 1 Digital representation of monochrome image.

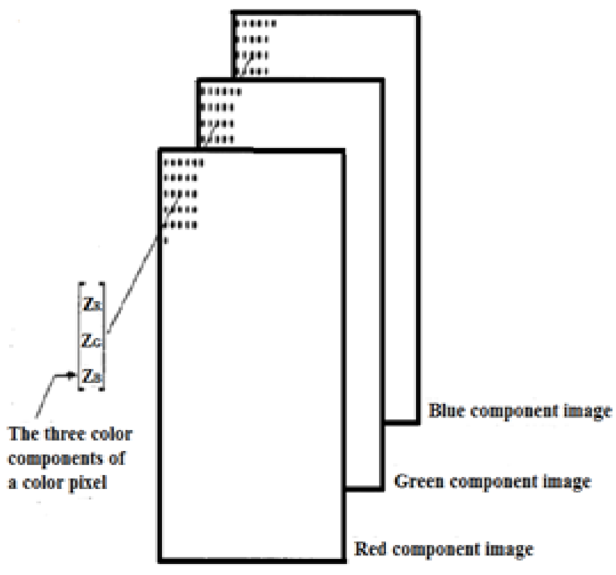

Fig. 2 Digital representation of RGB color system image..

2. Digital Measurements Image

Digital measurements image like digital image has two-dimensional function, f(x,y) , but x and y are spatial (plane) coordinates indicate the date and time for each measurement. The amplitude of f at any pair of coordinates (x,y) is called intensity of the image at that point which is the value of the measurement as shown in figure 3.

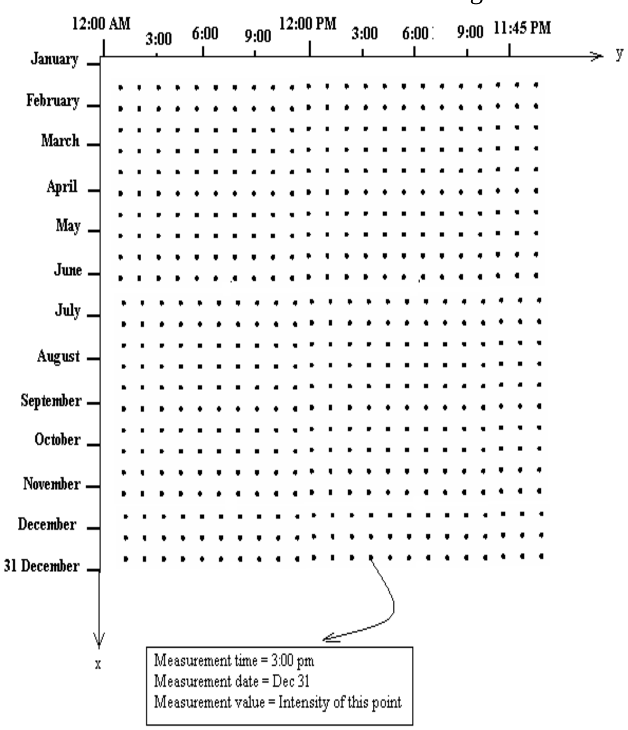

Fig. 3 Digital representation of measurements image..

3. Digital Radiation Image.

Digital radiation image is a digital RGB color measurements image for radiation levels in ambient air. These measurements are measured by a radiation monitoring station. This station is in constant place and operating for 24 hours daily. It measures a radiation level in ambient air every 15 minutes [2]. As shown in figure 4 the digital RGB color measurements image may be viewed as a "stack" of three gray-scale images that, when fed into red, green and blue inputs of a color monitor, produce a color image on the screen. By convention, the three images forming an RGB color image are referred to as the red, green, and blue component images. The x and y coordinates for this image represent the date and time for each measurement. The color for each pixel in this image represents the measurement value.

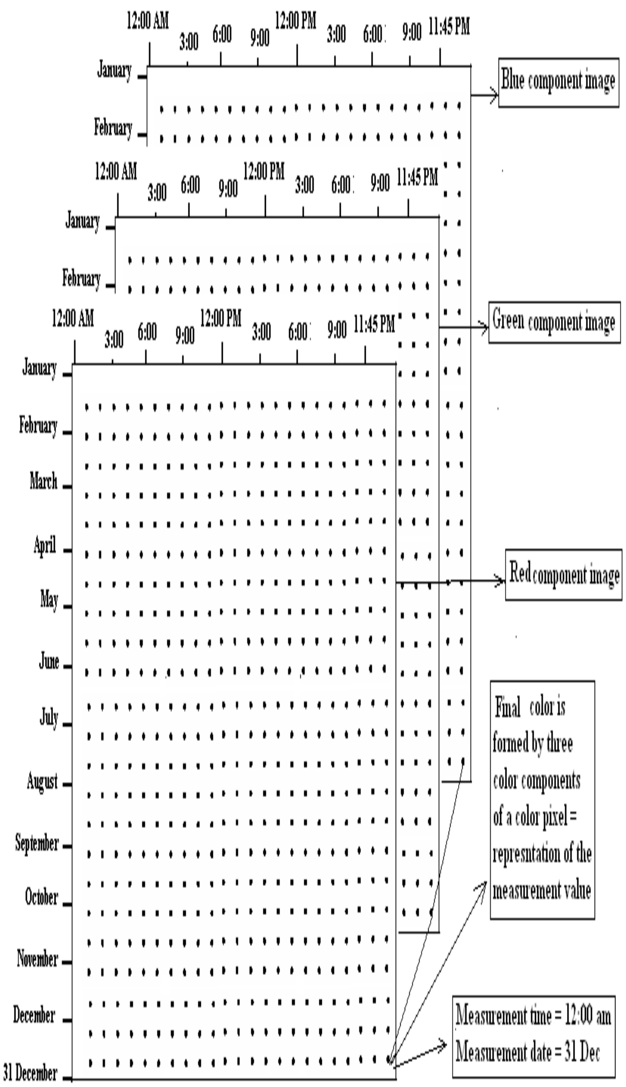

Fig. 4 Digital representation of digital radiation image.

4. Digital Radiation Image Creation

The processes for creating the digital radiation image are as follows:

1. Collecting all radiation measurements in one year from radiation monitoring station.
2. Putting these measurements in a 365 x 98 array of radiation measurements. The number of rows is equal the number of days in one year and the number of columns equals to the number of measurements in one day which equals to four measurements per hour multiplied by 24 hours daily.
3. Creating another three arrays. The size of each array is the same as the pervious array. The elements of the first array represent the red components, the elements of the second array represent the green components, and the elements of the third array represent the blue components.
4. Converting each radiation measurement to fuzzy number or linguistic status [3] according to allowed limit that is set up by environmental law number four in Egypt [4]. This is necessary to establish a meaningful system for creating a digital radiation image. The value for this allowed limit does not exceed 2.3 e-1 Micro Sv / hr. Table 1 shows all fuzzy numbers and their linguistic expressions used in this study.
5. Determining the color for each radiation measurement by using rule based structure of fuzzy logic [5]. The series of fuzzy rules for all measurements were recorded in one year defines the digital radiation image. Defining that Radiation Measurement as RM. These rules are as follows:-

R_{1} : IF RM IS **UL_ST1** THEN RM_color IS WHITE
R_{2} : IF RM IS **UL_ST2** THEN RM_color IS LIGHT BLUE SKY
R_{3} : IF RM IS **UL_ST3** THEN RM_color IS BLUE SKY
R_{3} : IF RM IS **UL_ST4** THEN RM_color IS LIGHT BLUE
R_{5} : IF RM IS **UL_ST5** THEN RM_color IS BLUE
R_{6} : IF RM IS **UL_ST6** THEN RM_color IS DARK BLUE
R_{7} : IF RM IS **NL_ST1** THEN RM_color IS LIGHT GREEN
R_{8} : IF RM IS **NL_ST2** THEN RM_color IS GREEN
R_{9} : IF RM IS **NL_ST3** THEN RM_color IS DARK GREEN
R_{10} : IF RM IS **AL_ST1** THEN RM_color IS VERY DARK GREEN
R_{11} : IF RM IS **AL_ST2** THEN RM_color IS LIGHT YELLOW
R_{12} : IF RM IS **AL_ST3** THEN RM_color IS YELLOW
R_{13}: IF RM IS **AbL_ST1** THEN RM_color IS LIGHT ORANGE
R_{14} : IF RM IS **AbL_ST2** THEN RM_color IS ORANGE
R_{15} : IF RM IS **AbL_ST3** THEN RM_color IS BROWN
R_{16} : IF RM IS **OL_ST1** THEN RM_color IS LIGHT PINK
R_{17} : IF RM IS **OL_ST2** THEN RM_color IS PINK
R_{18} : IF RM IS **OL_ST3** THEN RM_color IS DARK PINK
R_{19} : IF RM IS **OL_ST4** THEN RM_color IS LIGHT RED
R_{20} : IF RM IS **VOL** THEN RM_color IS RED
R_{21} : IF RM IS **NO_DATA** THEN RM_color IS BLACK

Table 1: Fuzzy numbers and their linguistic meaning.

Fuzzy number	***Linguistic meaning***	***Fuzzy value for measurement time***
UL_ST1	Under allowed limit stage one	0<= UL_ST1 <= (0.044* Allowed limit)
UL_ST2	Under allowed limit stage two	UL_ST1< UL_ST2 <= (0.087* Allowed limit)
UL_ST3	Under allowed limit stage three	UL_ST2< UL_ST3 <= (0.13* Allowed limit)
UL_ST4	Under allowed limit stage four	UL_ST3< UL_ST4 <= (0.174* Allowed limit)
UL_ST5	Under allowed limit stage five	UL_ST4< UL_ST5 <= (0.217* Allowed limit)
UL_ST6	Under allowed limit stage six	UL_ST5< UL_ST6 <= (0.261* Allowed limit)
NL_ST1	Near from allowed limit stage one	UL_ST6< NL_ST1 <= (0.304* Allowed limit)
NL_ST2	Near from allowed limit stage two	NL_ST1< NL_ST2 <= (0.348* Allowed limit)
NL_ST3	Near from allowed limit stage three	NL_ST2< NL_ST3 <= (0.393* Allowed limit)
AL_ST1	At allowed limit stage one	NL_ST3< AL_ST1<= (0.435* Allowed limit)
AL_ST2	At allowed limit stage two	AL_ST1< AL_ST2<= (1.304* Allowed limit)
AL_ST3	At allowed limit stage three	AL_ST2< AL_ST3<= (2.174* Allowed limit)
AbL_ST1	Above allowed limit stage one	AL_ST3< AbL_ST1<= (3.04* Allowed limit)
AbL_ST2	Above allowed limit stage two	AbL_ST1< AbL_ST2<= (3.91*
AbL_ST3	Above allowed limit stage three	AbL_ST2< AbL_ST3<= (4.34*
OL_ST1	Over allowed limit stage one	AbL_ST3< OL_ST1<= (13.04* Allowed limit)
OL_ST2	Over allowed limit stage two	OL_ST1< OL_ST2<= (21.73* Allowed limit)
OL_ST3	Over allowed limit stage three	OL_ST2< OL_ST3<= (30.43* Allowed limit)
OL_ST4	Over allowed limit stage four	OL_ST3< OL_ST4<= (34.18* Allowed limit)
VOL	Very over allowed limit	VOL > OL_ST4
NO_DATA	No data recorded at this date	Ø

6. Putting the value for red component in the first array, green component in the second array and blue component in the third array according to radiation measurement color produced from step number five. Hence the three images are ready for forming the RGB image which is the digital radiation image [6].

7. To make the final image more clear increase its width by repeating each pixel in every row four times. So, the resulted image dimension is 365 x 392.

5. Results and Discussion.

Important information can be obtained in just few minutes by watching the digital radiation image such as the value of maximum and minimum measurements in the year and date of them, the most repeated measurement value in the year and the number of times that the radiation station did not work with their date and time. As shown in figure 5 the following information can be estimated in few minutes about Gamma radiation measurements in Cairo city in 2007.Figure 6 show the color codes for fuzzy values

1. Maximum measurements values in year 2007 happened at period from 7th March to 15th November from 8:00 Am to 10:00 Am and their values are AL_ST1 and AL_ST2.
2. Minimum measurements value is UL_ST2 at various times in the year.
3. The most repeated value in the year is UL_ST6.
4. The number of days that the station did not work in this year is about seven days, two days in first week of June, two days in third week of July and three days in fourth week of July.

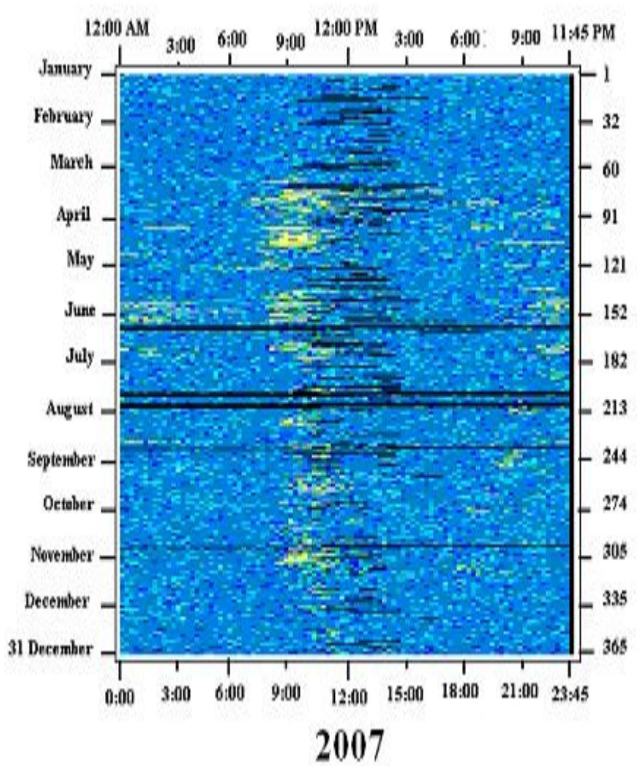

Fig. 5 Digital Radiation Image for Cairo city at 2007.

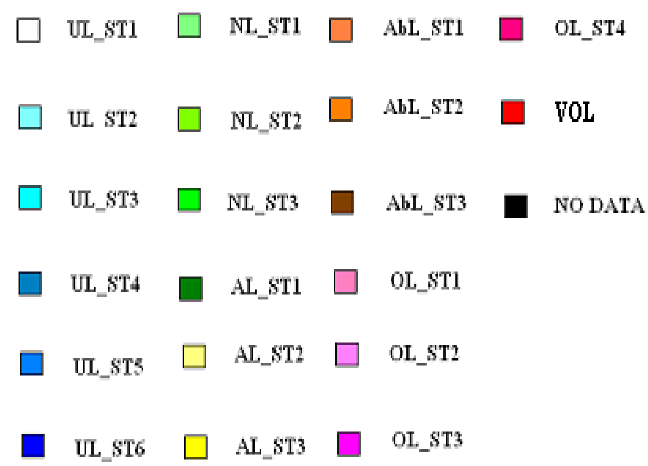

Fig. 6. Color codes for fuzzy values.

6. Conclusions

In some cases such as measurements included in a database of any digital monitoring system, huge number of measurement at different dates and times and studying the behavior of any kind of measurement the Digital Radiation image is more useful than conventional data visualization method because it has the ability to include thousands of measurements in a very clear form through only one photo while the maximum number of measurements does not exceed 100 for other conventional data visualization methods [7]. This feature gives a facility to view thousands or may be hundreds thousands of measurements in only one photo. This photo helps the user to study and analyze the behavior of these measurements in few minutes instead of spending few hours in reviewing hundreds of charts for the same measurements. So a huge amount of effort and time is saved by using the digital radiation image in those cases.

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