UNIVERSITY OF LUCKNOW

FACULTY OF ENGINEERING &TECHNOLOGY

E-Content : B. Tech.

CIVIL ENGINEERING (SEM – IV)

Geo-informatics

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INTRODUCTION

Electromagnetic energy reflected/emitted from the earth features may be detected and recorded either photographically or electronically. As a result, we either get a photograph or an image. In photographic process, chemical reactions are used on a film to detect the electromagnetic response recorded on the film.

So, a *Photograph* is specifically an image that have been recorded on photographic film & converted to paper form by using chemical processes on the surface of the light sensitive film, whereas, an *Image* refers to a pictorial representation of a scene & its information detected with electronic sensors generating different electrical signals.

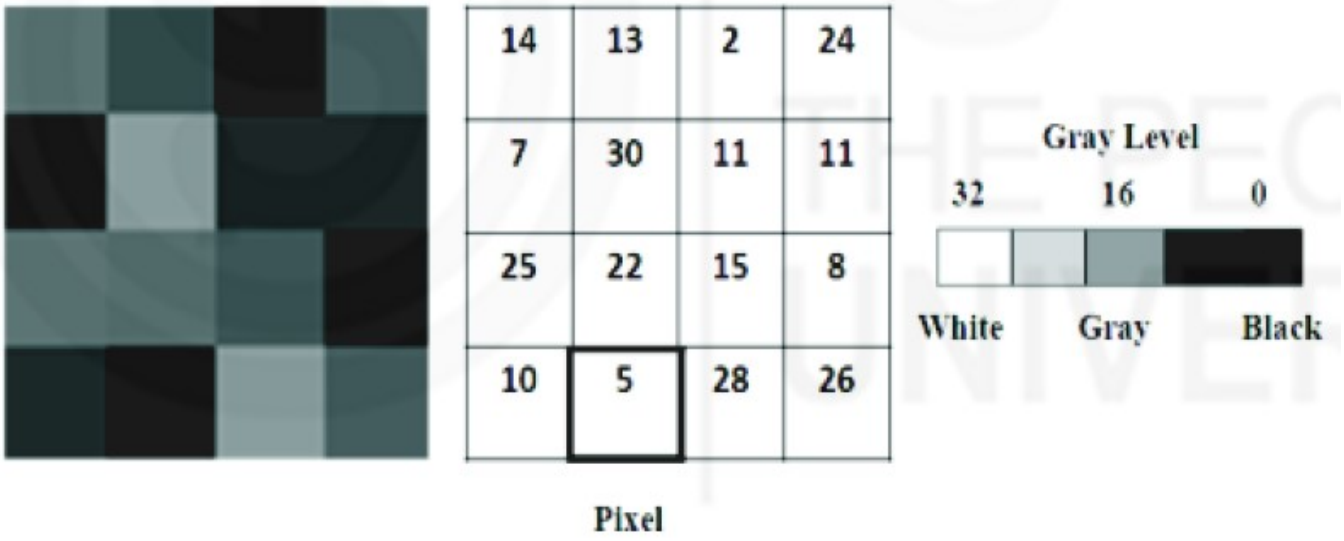
Now, mathematically, an ***Image*** is defined as a two-dimensional function $f(x, y)$, where x and y are the spatial (plane) coordinates of the image & the amplitude of function f at any coordinate (x, y) (in other words, any location in the image) is called the *intensity* or *gray level* of the image.

Thus, each pair of finite numbers (x, y), corresponds to a discrete dot on the image i.e. one discrete picture element. This is the smallest unit of an image, referred to as picture element, ***pixel*** or ***pel.***

An image is converted to numerical form before processing and this conversion process is called *Digitisation*. The image is divided into horizontal lines made up of adjacent pixels. At each pixel location, the image brightness is sampled and quantised. This step generates an integer at each pixel representing the brightness or darkness of the image at that point & the image is represented by a two-dimensional integer array of digitised brightness value. Thus, ***Digital Number*** is a positive integer representing the brightness of the corresponding pixel resulting from the spectral response of the scene. It is also sometimes referred as pixel value, gray level, image intensity or brightness value.

Thus, each pixel has the photographic information stored in the form of discrete numbers that are quantised based on the reflectance/electrical signals recorded by the sensors. These numbers vary

from place to place within the image depending upon the tonal variation. In any image, bright areas are represented by higher values whereas dark areas are represented by lower values.



A digital image (left) and its corresponding values (centre). Note the variation in the brightness and the change in the corresponding digital numbers. Highlighted block in the centre figure shows one pixel. The figure at right shows the range of values corresponding to the brightness

The DN values can be quantised /recorded over various numerical ranges depending upon the binary computer coding scales. These ranges may be recorded using 6-, 7-, 8-, 9-, or 10-bit binary codes. This will decide the number of discrete levels of colour intensity that can be distinctly featured in a digital image.

For example, an 8-bit system results in 2^8= 256 discrete integers or 256 discrete levels of intensity ranging from 0-255. It means there will be 256 different shades of the colour that can be assigned/ identified with a different brightness number. The pixel with least possible brightness value i.e. 0 signifies the darkest shade i.e. black colour where as the pixel with highest brightness value, 255, can be seen as the lightest shade i.e. white colour.

As said earlier, the image is a function of *(x, y)* which represent the spatial coordinates or location of a pixel. The origin of pixel coordinate system is considered to be the upper left corner of the image. The address of a pixel *(x, y)* in any 2-dimensional image space is given in discrete numbers, denoting the number of pixels along rows & the number of pixels down the columns from the origin. Number of pixels in an image depends upon the image size (length and width of the image).

Column →

Row ↓	1	2	3	4
1	14	13	2	24
2	7	30	11	11
3	25	22	15	8
4	10	5	28	26

(1,1)	(1,2)	(1,3)	(1,4)
(2,1)	(2,2)	(2,3)	(2,4)
(3,1)	(3,2)	(3,3)	(3,4)
(4,1)	(4,2)	(4,3)	(4,4)

Arrangement of rows and columns of an image of size 4 × 4 (4 rows and 4 columns). Left figure shows the numerical values in the image and the table at right shows the representation of pixel location for an image of size 4 × 4. You can observe that at location (1, 4), i.e. row 1 and column 4, the pixel value is 24

Thus, **Digital image** is defined as a 2-dimensional array of discrete picture elements i.e. *pixels*, each having a finite location & discrete pixel value i.e. *Digital Number* which is proportional to the brightness of the scene at that coordinate/location (*x, y*).