Image Processing And Pattern Generation

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ABSTRACT

Image processing usually refers to digital image processing, but optical and analog image processing also are possible. This article is about general techniques that apply to all of them. The acquisition of images (producing the input image in the first place) is referred to as imaging. Closely related to image processing are computer graphics and computer vision. In computer graphics, images are manually made from physical models of objects, environments, and lighting, instead of being acquired (via imaging devices such as cameras) from natural scenes, as in most animated movies. computer vision, on the other hand, is often considered high-level image processing out of which a machine/computer/software intends to decipher the physical contents of an image or a sequence of images (e.g., videos or 3d full-body magnetic resonance scans).in modern sciences and technologies, images also gain much broader scopes due to the ever growing importance of scientific visualization (of often large-scale complex scientific/experimental data). Examples include microarray data in genetic research, or real-time multi-asset portfolio trading in finance.

HISTORY OF IMAGE PROCESSING:

Many of the techniques of digital image processing, or digital picture processing as it often was called, were developed in the 1960s at the Jet Propulsion Laboratory, Massachusetts Institute of Technology, Bell Laboratories, University of Maryland, and a few other research facilities, with application to satellite imagery, wire-photo standards conversion, medical imaging, videophone, character recognition, and photograph enhancement. The cost of processing was fairly high, however, with the computing equipment of that era. That changed in the 1970s, when digital image processing proliferated as cheaper computers and dedicated hardware became available. Images then could be processed in real time, for some dedicated problems such as television standards conversion. As general-purpose computers became faster, they started to take over the role of dedicated hardware for all but the most specialized and computer-intensive operations. With the fast computers and signal processors available in the 2000s, digital image processing has become the most common form of image processing and generally, is used because it is not only the most versatile method, but also the cheapest. Digital image processing technology for medical applications was inducted into the Space Foundation Space Technology Hall of Fame in 1994.

INTRODUCTION

In recent years there has been much interest in using large scale homogeneous cellular array of simple circuits to perform image processing tasks and to demonstrate inserting pattern forming phenomena .The cellular neural network (CNN) first introduced.

1. As an implementable alternative to fully connected neural networks has evolved into a paradigm for these types of arrays.
2. The motivation for studying the usefulness of such arrays has included the biology of the retina, the system of morphogenesis and cellular automata. Example: Silicon retina
3. The general resistive grids, which have been able to produce many effects of linear and non linear spatial filtering and motion sensitive filtering.
4. The system motivated by the Reaction Diffusion Equation can produce effects in finger print enhancement, textile fault detection, pattern formation and synergetic.
5. The cellular automata based methods which can be used for mathematical morphology.
6. Modeling physical system such as ISMG spin glass.

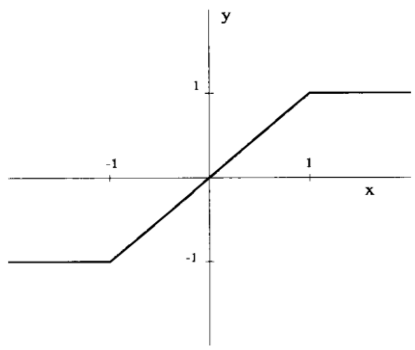


Fig. 1. The CNN output nonlinearity.

The simplest CNN cell has a single capacitor, giving it first order dynamic and it is coupled in neighboring cells through non linear controlled sources. The dynamic of the CNN is described by

$$\frac{d}{dt}x_{i,j}(t) = -x_{i,j}(t) + \sum_{k,l\in\mathcal{N}} A_{k,l}y_{i+k,j+k}(t) + \sum_{k,l\in\mathcal{N}} B_{k,l}u_{i+k,j+k} + I \qquad (1)$$

With the output nonlinearity

$$y(x) = \tfrac{1}{2}[|x-1| - |x+1|]$$

As shown in fig.1.

The emphasis on a template can be easily understood by writing (1) in block diagram form, as shown in fig.2.

Note that the correlation sums in the equation can be written as convolutions (denoted by an asterisk) by template reflection. From the diagram it can be seen that the B template forms a simple feed forward finite impulse response(FIR) filtered version of the input which itself can be considered as static input to the rest of the system .On the other hand , A template's operating in a feedback loop along with a nonlinearity a feature that gives interesting behavior.

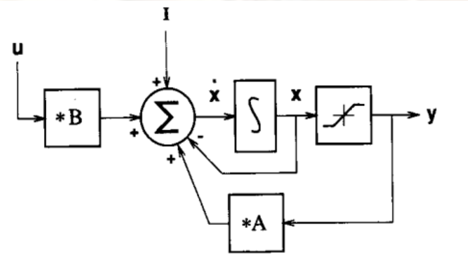


Fig. 2. A block diagram representation of the standard CNN.

THE ESSENTIAL BACKGROUND – THE CNN CENTRAL LINEAR SYSTEM

Because the output nonlinearly applied to the state (see fig.1.) is piecewise linear the state space can be considered to be the union of region where the dynamics are exactly linear? The most important region for this purpose is called central state space where all cells have states $-1 \le x_{i,j} \le 1$.IN this section we will see use of spatial frequency domain to write the time solving of the network.

SPATIAL CONVOLUTION FORMULATION:

In particular, the state evolution is written in terms of the convolution of two dimensional infinite spatial sequences.

SPATIALFREQUENCY FOMULATOIN:

Because of the spatial mixing introduced by the coupling, writing the time solution of above equation would not be very intuitive. However, it is straight forward to transform the system by a change of basis into one that is uncoupled, an approach that has a long history in morphogenesis literature.

If all $|x_{i,j}| < 1$, then $y_{i,j} = x_{i,j}$, and the whole system behaves according to the linear system

$$\frac{d}{dt}x_{i,j}(t) = -x_{i,j}(t) + \sum_{k,l\in\mathcal{N}} A_{k+i,l+j}x_{k,l}(t) + \sum_{k,l\in\mathcal{N}} B_{k+i,l+j}u_{k,l} + I$$

which we now assume to operate over all state space.

We will make use of discrete space Fourier transform (DSFT), which gives the representation of sequence I the basis of complex exponentials.

$$\tilde{F}(\omega_1,\omega_2) = \sum_{n_1}\sum_{n_2} f(n_1,n_2)e^{-j\omega_1 n_1}e^{-j\omega_2 n_2} \qquad (4)$$

and can be reconstructed by the Inverse DSFT

$$f(n_1,n_2) = \frac{1}{(2\pi)^2}\int_{-\pi}^{\pi}\int_{-\pi}^{\pi} \tilde{F}(\omega_1,\omega_2)e^{j\omega_1 n_1}e^{j\omega_2 n_2}\, d\omega_1\, d\omega_2. \qquad (5)$$

Some of the interesting properties of the DSFT along with some notation that will be used are as follows:

- Real Symmetric $f(n_1,n_2) \leftrightarrow \tilde{F}(\omega_1,\omega_2)$ Real Symmetric
- $f(0,0) = (1/(2\pi)^2)\int_{-\pi}^{\pi}\int_{-\pi}^{\pi} \tilde{F}(\omega_1,\omega_2)\, d\omega_1\, d\omega_2$. In fact, from the definition, it can be seen that $f(0,0)$ adds to the new basis representation equally and can therefore be considered an offset. That is, changing the center element $f(0,0)$ just shifts the curve $\tilde{F}(\omega_1,\omega_2)$ up or down.
- $f(n_1,n_2) * g(n_1,n_2) \leftrightarrow \tilde{F}(\omega_1,\omega_2)\tilde{G}(\omega_1,\omega_2)$
- $\delta(n_1,n_2)$ is the discrete *delta function* that is zero everywhere except $\delta(0,0) = 1$. $\delta(\omega_1,\omega_2)$ is the continuous support delta function that is zero everywhere except it has *area* one at the origin.

TIME SOLUTION:

The discussion on boundary conditions showed that we actually only need to study one differential equation to understand the behavior of any of these systems, The time solution can be written down for each w1,w2 from elementary linear system theory as follows:

When $A(\omega_1, \omega_2) \neq 0$:

$$\tilde{X}_t(\omega_1, \omega_2) = e^{\tilde{A}(\omega_1,\omega_2)t}\tilde{X}_0(\omega_1, \omega_2) + \frac{1}{\tilde{A}(\omega_1, \omega_2)} \cdot [e^{\tilde{A}(\omega_1,\omega_2)t} - 1]\tilde{B}(\omega_1, \omega_2)\tilde{U}(\omega_1, \omega_2). \quad (7)$$

When $\tilde{A}(\omega_1, \omega_2) = 0$:

$$\tilde{X}_t(\omega_1, \omega_2) = \tilde{X}_0(\omega_1, \omega_2) + t\tilde{B}(\omega_1, \omega_2)\tilde{U}(\omega_1, \omega_2). \quad (8)$$
(

STABLE CENTRAL LINEAR SYSTEM

To help develop an intuitive notion for behavior of (7), we will make separate studies of stable and unstable operation. It will be shown that this division leads to qualitatively different image processing and pattern formation behavior.

1. **Equilibrium linear spatial Filtering**
   Example (i). Low pass filter design.
2. **Time varying spatial filtering**
3. **Design Issue**
4. **Saturated Behavior**

UNSTABLE SATURATED BEHAVIOR:

3.1. Autonomous behavior
3.1.1. Linear Pre filtering
3.1.2. Morphological constraint
3.2. Non Autonomous Behavior

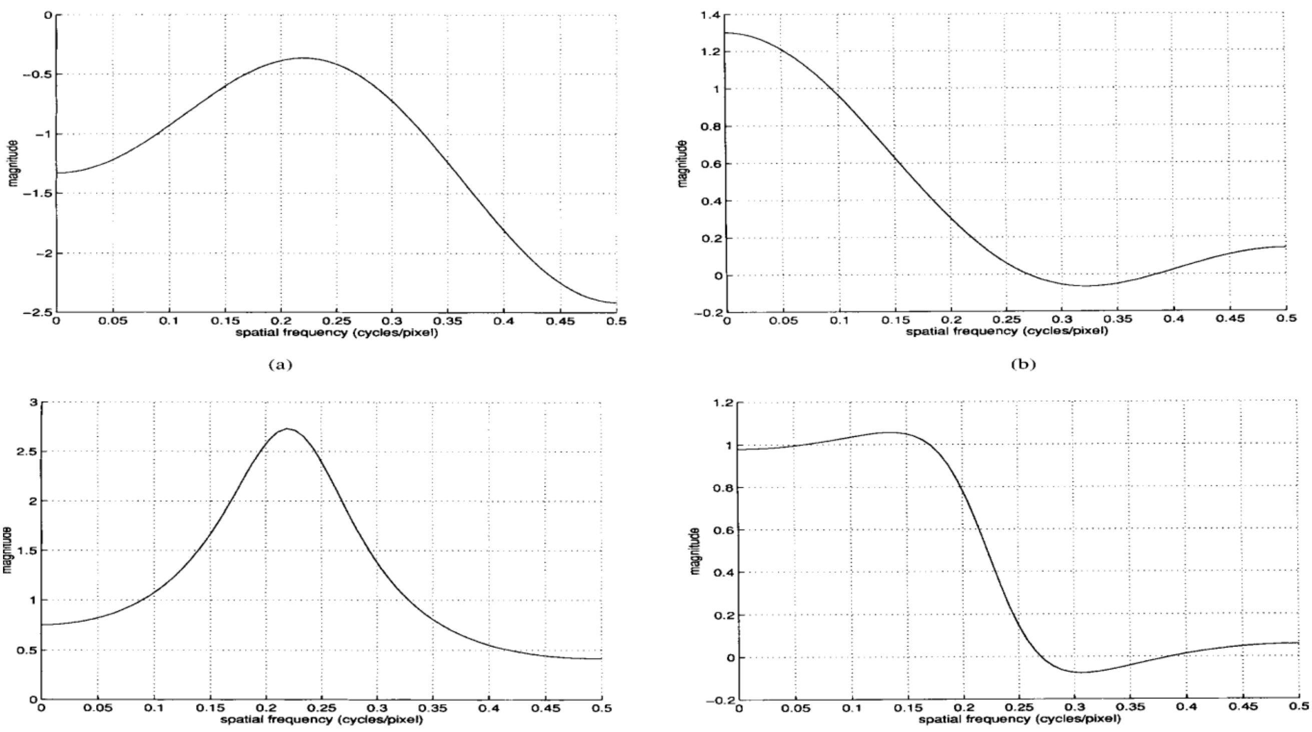
Methods of Image Processing

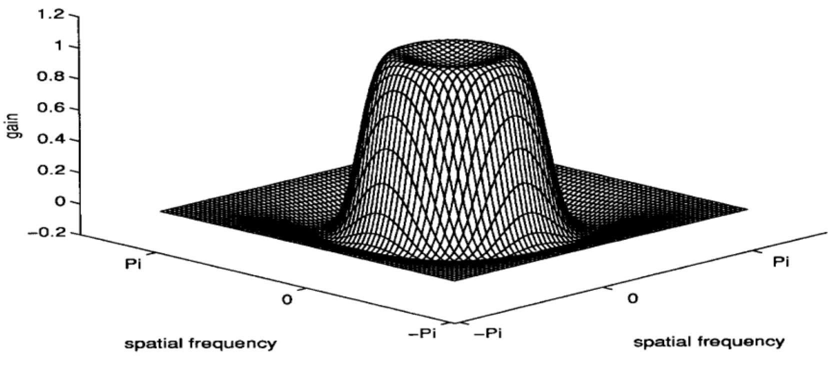
There are two methods available in Image Processing.

Analog Image Processing

Analog Image Processing refers to the alteration of image through electrical means. The most common example is the television image.

The television signal is a voltage level which varies in amplitude to represent brightness through the image. By electrically varying the signal, the displayed image appearance is altered. The brightness and contrast controls on a TV set serve





to adjust the amplitude and reference of the video signal, resulting in the brightening, darkening and alteration of the brightness range of the displayed image.

Digital Image Processing

In this case, digital computers are used to process the image. The image will be converted to digital form using a scanner – digitizer [6] (as shown in Figure 1) and then process it. It is defined as the subjecting numerical representations of objects to a series of operations in order to obtain a desired result. It starts with one image and produces a modified version of the same. It is therefore a process that takes an image into another.

The term digital image processing generally refers to processing of a two-dimensional picture by a digital computer [7,11]. In a broader context, it implies digital processing of any two-dimensional data. A digital image is an array of real numbers represented by a finite number of bits.

Image Enhancement Techniques

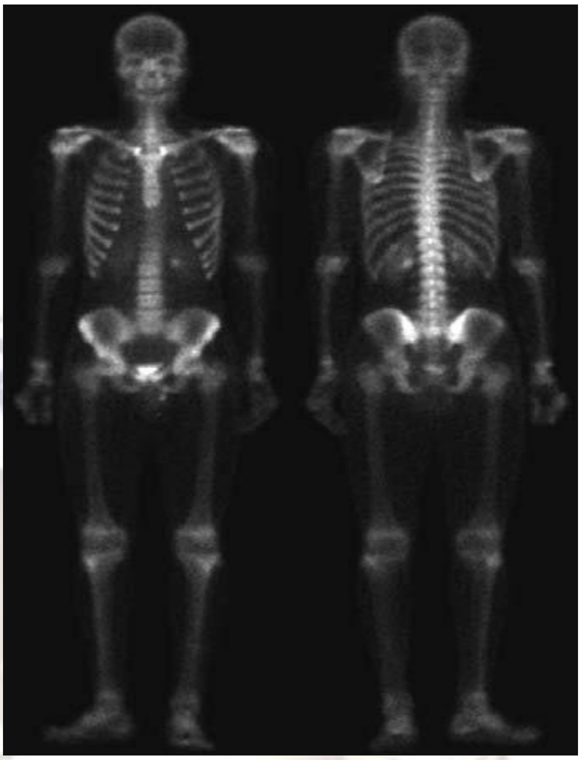
Sometimes images obtained from satellites and conventional and digital cameras lack in contrast and brightness because of the limitations of imaging sub systems and illumination conditions while capturing image. Images may have different types of noise. In image enhancement, the goal is to accentuate certain image features for subsequent analysis or for image display [1, 2]. Examples include contrast and edge enhancement, pseudo-coloring, noise filtering, sharpening, and magnifying. Image enhancement is useful in feature extraction, image analysis and an image display. The enhancement process itself does not increase the inherent information content in the data. It simply emphasizes certain specified image characteristics. Enhancement algorithms are generally interactive and application-dependent. Some of the enhancement techniques are:

- Noise Filtering
- Histogram modification
- Contrast Stretching

FIELDS THAT USE IMAGE PROCESSING:

1. Gamma-Ray Imaging

Major uses of imaging based on gamma rays include nuclear medicine and astronomical observations. In nuclear medicine, the approach is to inject a patient with a radioactive isotope that emits gamma rays as it decays. Images are produced from the emissions collected by gamma ray detectors. Figure 1.6(a) shows an image of a complete bone scan obtained by using gamma-ray imaging. Images of this sort are used to locate sites of bone pathology, such as infections



2. X-Ray Imaging

X-rays are among the oldest sources of EM radiation used for imaging. The best known use of X-rays is medical diagnostics, but they also are used extensively in industry and other areas, like astronomy. X-rays for medical and industrial imaging are generated using an X-ray tube, which is a vacuum tube with a cathode and anode. The cathode is heated, causing free electrons to be released. These electrons flow at high speed to the positively charged anode.

When the electrons strike a nucleus, energy is released in the form of X-ray radiation. The energy (penetrating power) of X-rays is controlled by a voltage applied across the anode, and by a current applied to the filament in the cathode. Figure 1.7(a) shows a familiar chest X-ray generated simply by placing the patient between an X-ray source and a film sensitive to X-ray energy.

Some of other applications are briefly discussed below.

1. **Imaging in the Ultraviolet Band**
2. **Imaging in the Visible and Infrared Bands**
3. **Imaging in the Microwave Band**
4. **Imaging in the Radio Band**
5. **Remote Sensing**
6. **Medical Imaging**
7. **Non-destructive Evaluation**
8. **Forensic Studies**
9. **Textiles**
10. **Material Science.**
11. **Military**
12. **Film industry**
13. **Document processing**
14. **Graphic arts**
15. **Printing Industry**

ADVANTAGES:

1. No scaling – no associated resampling degradations.
2. Shear can be implemented very efficiently

FUTURE SCOPE:

Adaptive interrogation of large image data bases-These parameters can be divided into several categories as follows:

Engineering, Spacecraft and Footprint Data

Examples:

Spacecraft Position and Orientation Camera Filter Position Solar Elevation Angle Image Footprint (Longitude and Latitude) Location of Digital.

Film Versions

Examples:

Tape and .File Number of Raw Image Roll and Frame Number for Film Products Microfiche Card Position Dataset Name on Disk

II. UTILIZATION OF GRAPHICS DATA WITH IMAGERY

III. DISPLAY OF MULTISPECTRAL IMAGERY

CONCLUSION:

In this paper we have discussed mathematical explanation and methods of image processing. We have seen traditional classification of image processing and how patterns are generated in this scheme. Image processing has lots application in different fields. So we can say that this method is very useful for recent scenario.

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