APPLICATIONS OF DIGITAL IMAGE PROCESSING IN ASTRONOMY

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OUTLINE

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RÉFERENCES

WHAT IS ASTRONOMY?

- Astronomy is a study on celestial objects and phenomena.
- It comes under the field of natural science
- Natural science is a branch of science that involves explaining, analyzing and understanding natural phenomena.
 - Any phenomena that happens beyond the Earth atomosphere can be considered as a point of interest in the field of astronomy



HOW HUMANS PERCEIVE IMAGES?

- Humans perceive images through eye
- When light falls on retina the image is perceived
- There are cones and rods to sense light(colour) and dark(grayscale images) respectively
- The visible range of light for a normal human eye is referred to as visible spectrum(380 to 720 nanometers)



THE NEED FOR IMAGE PROCESSING

• Because of the presence of noise, atmospheric turbulences ,gamma rays, UV rays,etc their presence can distort the view of the image to a normal human eye or even under extreme conditions it might not be visible to the human eye. Thus image processing can be used as a means for capturing, retaining and analyzing the image in space(beyond earth's atmosphere). Example: a planet surface



Images taken during apollo 15 landing site [1]

APPLICATIONS OF DIGITAL IMAGE PROCESSING IN ASTRONOMY

COMBINING FILTERS AND CCD (IMAGE ACQUISTION AND PROCESSING)

- The telescope uses a charge coupled device(CCD) to get a raw image.
- A CCD is a device that turns light into electrical signals
- The output is stored in the form of a multidimensional matrix and image processing software is used to assign colours to the respective values
- Usually the telescope with the CCD takes the image using 5 filters(represented as u,g,r,i and z). The images from those filters are grayscale image. In order to get a color image these images from the filter has to be combined(any 3 can be chosen)
- /There are many softwares which are used for image processing for Example: AIPS,Mira AP

Fun fact:Astronomical Images are stored in FITS(Flexible image transport system) format not in GIF OR JPEG.Special software is required to view those type of images.What we see in web are images(related to astronomy) that are added with natural colors using filters.ex:IRIS





MAXIMUM ENTROPY RESTORATION (IMAGE RESTORATION)

- This technique is used to restore degraded images.
- Images which contain noise effects, film grain, defocussing, images taken during motion, blurred can be considered as a degraded image
- In addition to these there are many different types of noise effects
- Basically the problem can be solved with the following steps
- 1.Identify the type of Blur and try to find out the type of mask(kernel) and noise variance
 - 2.Restore the image with the known parameters such as mask(kernel),degraded image and noise variance value to get the original signal



IMAGE STRECHING

- Images which are in long distance are often small in size
- In order to increase the detail of the images they have to be stretched. This
 process is known as image stretching
- It also improves signal strength of the incoming image to get a better output
- Many type of functions are used involving image stretching
- These functions are taken and a power value is applied to each of them(linear, quadratic, cubic) and benchmark each output as a graphical representation(x-axis: normalized input y-axis:stretched normalized output)

During benchmarking you can understand how much you can stretch the image such that output image has enough details to it

Functions are Log(1+x), asinh(x), etc



SOME IMPORTANT DEFINITIONS

- LIGHT YEARS: distance that light travels in a year(in vacuum). It is an measurement of astronomical distance
- KERNEL: It is also known as a mask. It is a matrix which is used along with convolution on an image.
- NORMALIZATION: adjustments in the value or in the distribution
- ENTROPY: It is a measure of randomness. It is used to denote the texture of an image

REFERENCES

- 1. Wikipedia
- 2. Google images
- 3. <u>http://skyserver.sdss.org/dr8/en/proj/advanced/processing/</u>
- 4. http://www.clarkvision.com/articles/astrophotogra phy-rnc-color-stretch/

