ISSN 2063-5346

A HISTROICAL REVIEW OF IMAGE PROCESSING OPERATIONS FOR ASTRONOMICAL IMAGES IN SPACE APPLICATIONS FOR COMMUNICATION PURPOSES USING DIGITAL IMAGE PROCESSING CONCEPTS

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Article History: Received: 10.05.2023 Revised: 29.05.2023 Accepted: 09.06.2023

Abstract

In this paper, we present the developmental strategies for the image processing operations for different types of astronomical images in various space applications. The article serves as a strong review article so that the various authors who read to it get a glimpse of the different types of image processing operations such as segmentation, pre-processing, capturing, feature extraction, classification, noise-removal & other various digital image processing operations. Image Processing in Astronomy is a significant field of research and includes a great deal of procedures relating to improve investigating the properties of the divine items or getting primer surmising from the picture information. In this paper, we give a complete contextual analysis of cutting-edge picture handling procedures applied to Astronomical Galaxy Images for further developed investigation, exact derivations and quicker examination. Image handling is one of the quickest developing advances in designing field. It has its applications in different fields. Utilizations of picture handling in various fields like Automation and Robotics, Remote detecting, Biomedical, Defense, Hand motion acknowledgment, biological investigation, Document handling, Photography, Materials Research, Space investigation and Space science

Keywords: Image, Astronomy, Process, Simulation, Result, Application, Remote Detection.

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DOI:10.48047/ecb/2023.12.9.118

1. Introduction Remarks

Image Processing is the aggregate term given to methods or techniques used to handle a picture for examination, highlight extraction, object discovery, and so on. Image Processing has a few applications in for the most part all sort of areas including clinical science, cosmology, mechanization industry among numerous others [1].

Image processing has become increasingly significant as astronomy has progressed, and it has played a crucial part in astronomical research. Because raw astronomical photos often contain noise and blur, they can't be used for analysis or research. And as the quality of the image improves, the size of the celestial image expands. As a result, storing and transmitting these big image files is tough. As a result, image processing in astronomy is necessary, such as compression, denoising, segmentation, and restoration [2].

Image handling is a methodology used to perform different procedure on pictures to extricate required data. The process includes change of pictures into computerized structure to extricate helpful data. Image handling has different purposes, for example, to distinguish the items that are not perceptible, to deliver clear pictures, to quantify different articles in a picture, to separate the items in a picture and to recognize the examples in a picture. It has different stages which imports pictures, examinations and controls pictures and at last gives the outcome dependent on the prerequisite [3].

There are two techniques open for taking care of pictures for instance, simple and computerized picture taking care of. Picture taking care of sees pictures as two layered signs. Simple picture taking care of is applied on two layered signs and pictures are altered by electrical signs. Progressed picture taking care of incorporates PCs to control progressed pictures. The computerized taking care of uses explicit advances, for instance, preprocessing, improvement and show information recuperation. Fig. 1 gives a photographic view of different types of astronomical images that could be used for a host of telescience applications [4].

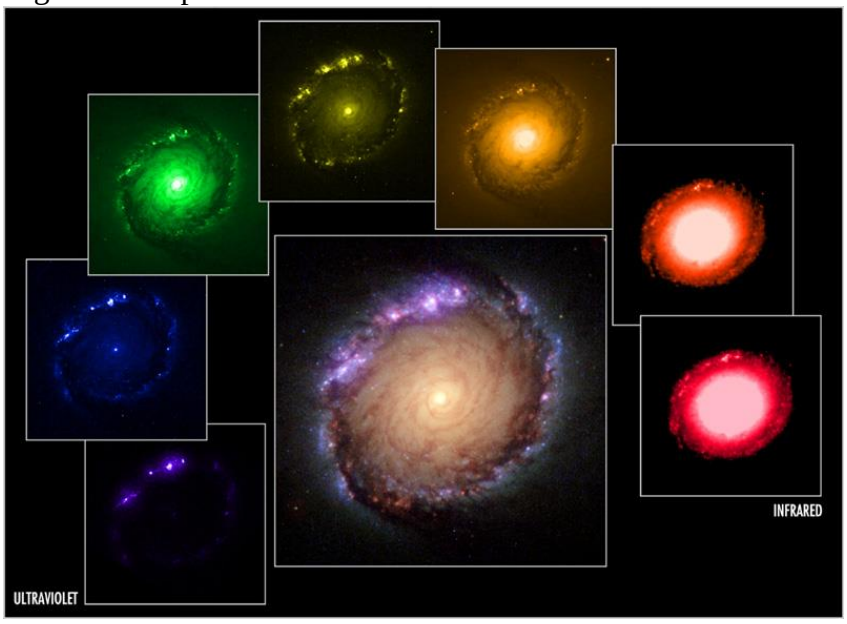


Fig. 1 : A photographic view of different types of astronomical images that could be used for a host of telescience applications

Picture Processing close by Digital Signal Processing is significantly critical in Astronomy especially with the new movements in space examination and the mechanical progression of more generous and indeed solid observatories with every

one of the greater telescopes. The use of Image Handling and Digital Signal Processing in Astronomy varies from ID and portrayal or game plan of superb things, concluding the division from earth, understanding the genuine properties of the subject in the image by performing range examination using the sign data [5].

Astrophotography, often known as astronomical imaging, is the photography or imaging of celestial objects, events, or portions of the night sky. Specialized and increasingly huge optical telescopes were built as giant cameras to record images on photographic plates. The complete research is structured as follows: The literature review is discussed in Sections I through IV. Section II discusses the literature review; Section III talks the image processing methodology; and Section IV covers the conclusion.

2. Literature Reviews / Surveys

In this section, the review on the various imaging applications that could be used for a host of image processing applications is presented in a nut shell. In [7], the Authors have made a book depicting about imaging and controlling pictures. It gives a start to finish assessment of how the image taking care of capacities. It helps people in discovering with respect to the unfathomable potential in modernized imaging that has been delivered by space science. In [8], The Authors have given a depiction on a versatile channel for handling for galactic pictures which has been created. The channel is competent is perceiving the nearby sign goal and furthermore adjusts its own reaction to this goal.

The authors in [9] have presented various methodologies that are used to evaluate the information in a cosmic picture. The results achieved are assigned at information and significance with an accentuation on exploratory results in cosmic picture and sign taking care of. Like this, a large number of researchers have worked on the application of image processing in astronomical images. Here, only a few of the relevant ones has been presented to get a conceptual view of the same. Fig. 2 gives a pictorial representation of the Hubble space images taken from the satellites.

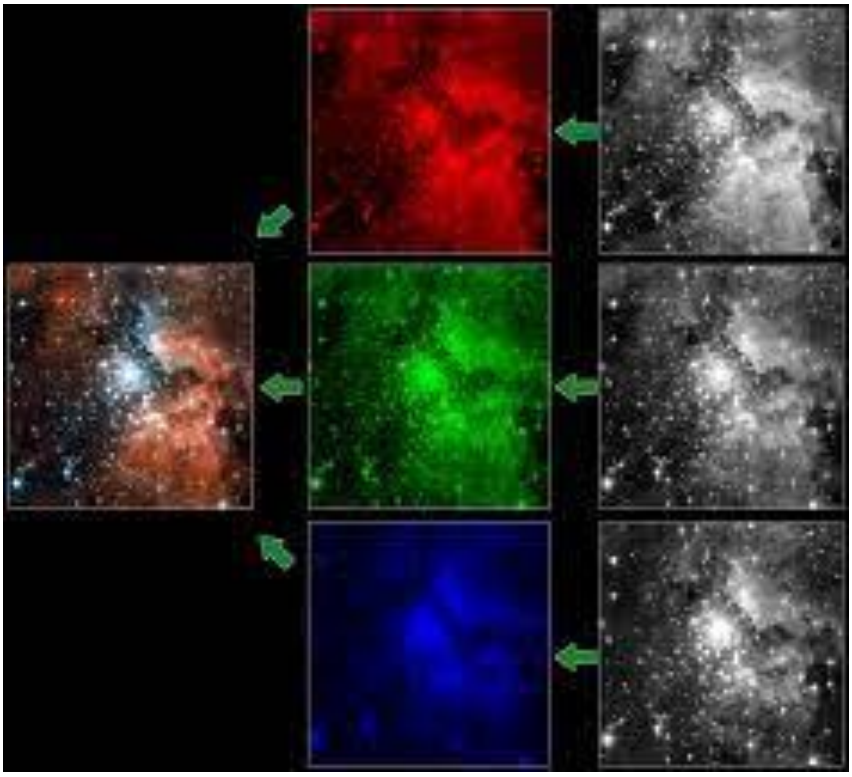


Fig. 2 : Pictorial representation of the hubble space images taken from the satellites

Digital image processing has a wide range of applications in new research areas such as satellite imaging, medical imaging, biometrics, and underwater imaging, to name a few. Another demanding area of research is astronomical image processing, where digital image processing ideas are heavily applied in analysis and processing activities. In the realm of astronomy, there are contributions, particularly those dealing with noise signals in images taken by charge coupled devices (CCD) cameras. In modern astronomical science and research, image enhancement and restoration techniques play a critical role [39] [43]. In general, the complete space image processing recognition system could be summarized as consisting of different blocks with each block having its own functionality & all the blocks could be used for any space astronomical research work [6] [44].

- Database (general / generated one)
- Image acquisition/capturing
- Gray scale conversion
- Identification of ROI
- Pre-processing
- Re-sizing
- Boundary detection
- Segmentation
- Localization
- Normalization
- Noise removal
- Enhancement
- Feature processing
- Feature extraction
- Feature encoding
- Matching
- Classifiers
- Testing
- Decision taking
- Authentication
- Identification
- Recognition /Matched
- Non-recognition/Un-matched

3. Cosmic Picture Analysis

Cosmic picture handling is an innovation used to recognize and break down the items caught through telescope or electronic finders called Charge Coupled Device(CCD). Objects caught through Telescope are dependably greyscale furthermore they will have some shading data. Different telescopes and locators have different sensitivities to various frequencies (colors). Shading channels can likewise be used to catch cosmic pictures. Electronic detectors, such as a CCD, are commonly used to capture images of celestial objects (Charge Coupled Device). Ordinary digital cameras include similar detectors. Although telescope photos are almost typically greyscale, they do contain some colour information. Fig. 3 gives the flow chart for the canny edge detection that could be used for edge detection concepts in astronomical image processing applications. A colour filter can be used to capture an astronomical image. Different detectors and telescopes are frequently sensitive to different colours in different ways (wavelengths) [7] [42].

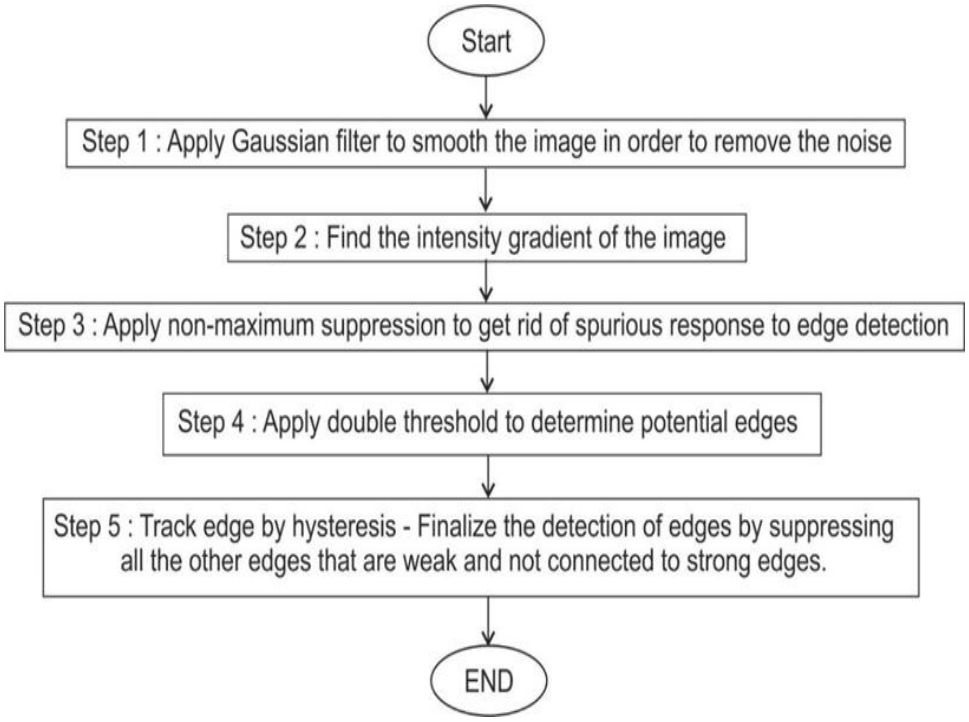


Fig. 3 : Flow chart for the canny edge detection

The different image processing applications in space that could be used are Pre-processing (P), Segmentation (S) & Normalization (N) and again these concepts could be implemented by using algorithms such as follows [8] [41].

Pre-Processing can be done by

1. PSN 1 : Canny Edge Detection & Circular Hough Transforms
2. PSN 2 : Hough Transform & Canny Edge Detection
3. PSN 3 : Fuzzy Trapezoidal & Sobel Operator Method
4. PSN 4 : OTSU Threshold Values & Boundary Detection Methods
5. PSN 5 : Morphological Operators
6. PSN 6 : Canny Edge Detection Method & Hough Transforms (Periocular)

Feature extraction (FE) using

1. FE 1 : Local Binary Pattern features Method
2. FE 2 : Gabor Wavelets
3. FE 3 : 1D Log Gabor Convolution Wavelet & Hybrid SVD Decomposition
4. FE 4 : SFTA Method
5. FE 5 : GLCM Method & Fruit Fly with Cuckoo Search Algo - Heuristic Algo
6. FE 6 : Local Binary Pattern features Method

Classification (CN) using

1. CN 1 : Mutli-SVM
2. CN 2 : Hamming Distance
3. CN 3 : Hausdorff Matching & Surf Matching
4. CN 4 : Knowledge Data Base & Neural Network Algo
5. CN 5 : RBFNN, Neural Network & SVM
6. CN 6 : Hamming Distance Method

4. Filtering Operations

NASA/ESA Hubble Space Telescope contains static number of channels. Channels are grouped into expansive band and tight band. Wide band channels permit wide scope of frequencies to length through for instance, red or green space of range. Tight band channels permit little frequencies to range through restricting the communicated radiation to that coming from a given nuclear progress letting space

experts to analyze each and every nuclear processes in the object. The investigation of Galaxies is finished involving expansive band channels as they let all the more light to go through and is displayed. As the different cycles happen in a world are very complex and depend on the result of millions of stars, slender band channels can't be utilized [9] [38].

5. Alloting colors to different filter exposures:

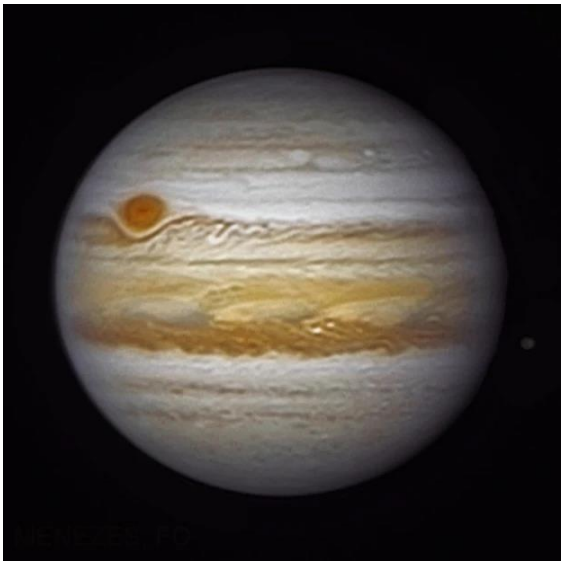
The raw data received by the astronomers is quite different from the processed data on the web sites. The pictures or images captured through detectors or telescope may not be sufficient to analyse or understand. Very attractive images constructed from the images taken to understand the physical process for some specific purpose [10] [37]. Picture Processing in Astronomy is a large topic of study that includes a variety of approaches for bettering the analysis of celestial object attributes or deriving early inferences from image data. We present a detailed case study of sophisticated image processing algorithms applied to Astronomical Galaxy Images for better analysis, more accurate conclusions, and faster analysis in this research [11] [36]. Fig. 4 gives a view of the moon astronomical image captured by one of the satellites which could serve as one of input images.

6. Image Compression

With the advancement of technology, images have become a more important medium of communication. When studying astronomical photographs, however, we see that high-quality images are always enormous in size and contain large databases. As a result, it's worthwhile for data providers and users to employ the most efficient image compression algorithms. Many industries, such as medicine, remote sensing, and astronomy, require image compression. Compression lowers the cost of storage medium and the network bandwidth required to deliver files to consumers [12] [40].

7. Data analysis

During data analysis processes, image compression also minimises the amount of bytes of data transported to and from local drives. We learned in few of the papers that the extensive literature on astronomical image compression can be divided into two main categories: loss compression, in which some information (ideally only noise) is discarded, and lossless compression, in which all information is preserved and the original data can be precisely reconstructed. By definition, lossless compression maintains all of the information in the images and is frequently preferable or necessary in circumstances where the data source requires it [13] [39].



7. A view of the moon astronomical image captured by one of the satellites

8. Natural colour images

To develop normal shading pictures, the succession of the tones designated to various openings ought to resemble the most reduced frequency ought to have a blue tint, the center frequency a green tone and the most elevated frequency ought to have red. Broad-band (Wide) or narrow-band (Narrow-band) filters are available (Narrow). A broad-band filter allows a large variety of colours to pass through, such as the whole green or red spectrum. A narrow-band filter enables just a limited wavelength span get through, essentially limiting the

transmitted radiation to that from a single atomic transition and allowing astronomers to study particular atomic processes in the object [14] [35].

9. Enhanced or improved colour images:

Sometimes we don't need to follow the sequence of colors for an image as shown in the Figure 10 which is called as enhanced colour image. Raw data must be manipulated during the data reduction and analysis process. This is perfectly suited to computers and software with the advent of digital detectors. Various software packages have been developed expressly for astronomical picture processing in the past, for example: IRAF. Take note of the PYRAF Python interface in particular. GAIA FIGARO XVISTA: Caltech MIDAS: European AIPS: radio MIDAS: European AIPS: radio MIDAS: European AIPS STSDAS (Space Telescope), PROS (X-ray), DAOPHOT (stellar photometry), SeXtractor are examples of add-on packages (source detection). Fig. 5 gives the flow-chart for astronomical image processing & particle counting in space images [15] [34]

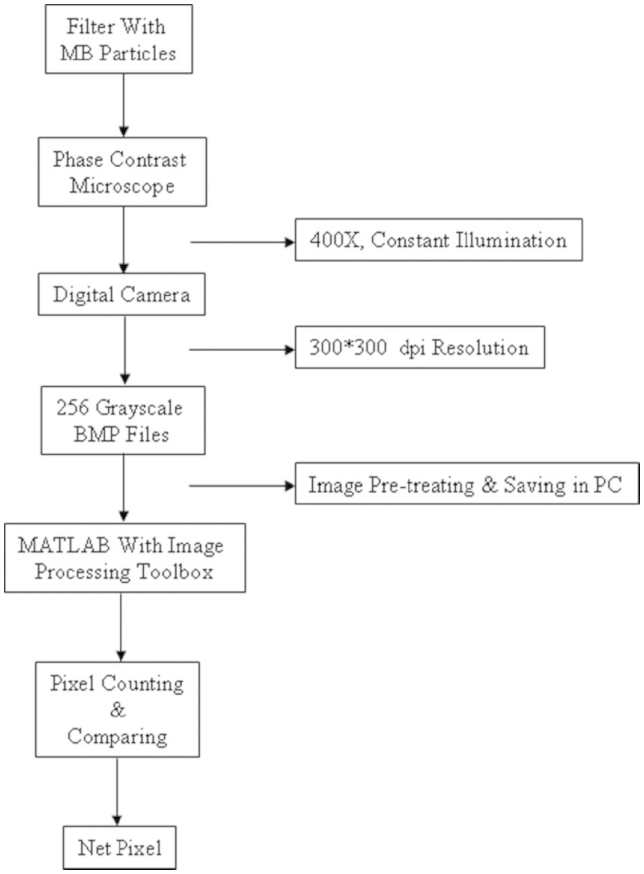


Fig. 8 : Flow-chart for astronomical image processing & particle counting in space images [43]

10. Methodology Adopted

Image Processing assumes a crucial part in comprehension, dissecting and deciphering galactic pictures. Beginning from Picture Smoothening, Noise expulsion, Edge Detection and Shape Mapping to Object Segmentation, advanced picture handling joined with signal handling is a strong set of apparatuses for stargazers to utilize while examining galactic information. In the following paragraphs, the exploration results along with the use of different numerical calculations and methods have been portrayed exhaustively [16] [32].

These all have different strengths and weaknesses, such as availability, cost, GUI/command line, data handling (disc vs. memory), speed, ease of use (e.g., keywords

vs. parm files), language and access to existing code, ability to add new code, scripts/ procedures, and so on (internal control language). Most of these programmes realised the usefulness of scripting and repeating actions for a large number of photos, and as a result, they included scripting features. With the advent of scripting languages such as IDL and Python, the focus has shifted away from astronomy-specific packages and toward routines written in, or callable from, a generic scripting language [17] [33].

11. Extrema Analysis

Generally, in Galaxy Imaging, telescopes frequently catch pictures containing worlds alongside groups of stars and other divine items. Accurately distinguishing the Galaxy inside the picture is the starter venture prior to moving towards investigating the cosmic system subject. Extrema Analysis shows to be inconceivably important in such cases to find neighborhood maxima furthermore minima inside the picture for division. Due to the uproarious qualities of the information picture, h-maxima were applied with a level of 0.05 for leaned toward results. The h limit is scaled with the one of a kind degree of the picture and addresses the grayscale level known as height by which the calculation needs to plunge to possibly appear at a higher most imperative which is believe it or not region contrast noticeable in the picture [18] [31].

12. Shape Index Analysis

Starter examination in inestimable picture taking care of fuses understanding the layered properties or the shape record profile of the heavenly article in the image. Unravelling the shape list, bearing rundown and layered profile of the thing helps stargazers with precisely perceiving the class it has a spot with and moreover to coordinate coming about research on it. Shape Index Profile is a singular regarded substance assessing the local curve and is gotten from the Eigen potential gains of the Hessian [19] [30].

What software should you get acquainted with? Many instruments now necessitate time-consuming data reduction activities. Frequently, the instrument team or observatory will provide routines (in a package) for performing these tasks. In general, it may be more convenient to use these procedures rather than reprogram them with your preferred tool! As a result, you're undoubtedly in a situation where you'll need to know how to use a variety of tools [20] [29].

Another way to look at it is that if you want to be at the cutting edge, you'll have to work with new instruments and/or approaches. Standard analysis may not be able to take full advantage of new data, or even operate at all. So you'd like to be in a position where you can design tools on your own [21] [28].

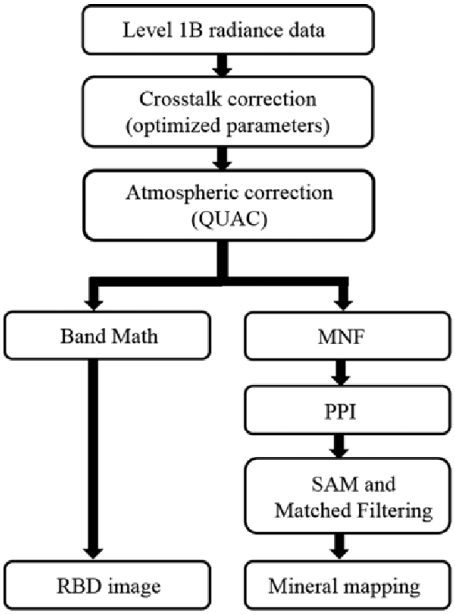


Fig. 9 : Flow-chart for pre-processing & filtering concept implementation from atmospheric images [45]

13. Image Gradients

Extrema Analysis shows to be exceptionally useful in such cases to find neighborhood maxima furthermore minima inside the picture for division. Due to the loud qualities of the information picture, h-maxima were applied with a level of 0.05 for really inclined in the direction of results. Fig. 6 gives the flow-chart for preprocessing & filtering concept implementation from

atmospheric images The h limit is scaled with the strong degree of the picture and addresses the grayscale level known as height by which the calculation needs to plunge to possibly appear at a higher most conspicuous which is for sure area contrast unmistakable in the picture [22] [27].

With recent breakthroughs in space exploration and the technological creation of more robust and technically sound observatories with more powerful telescopes, image processing and digital signal processing are becoming increasingly crucial in astronomy. The applications of Image Processing and Digital Signal Processing in Astronomy range from the identification and classification of celestial objects to establishing their distance from Earth and analysing the physical attributes of the topic in the image through spectrum analysis using signal data [42].

14. Simple Cells Filter-Bank Analysis

Ordinarily handling channel banks incorporates significant mathematical foundations for picture game plan, in any case, Straightforward cell examination is invigorated by the responsive fields found in mammalian fundamental visual cortex by using clear Gabor channels on the retinal perspective of the primary picture as to fabricate the channel bank. Fig. 7 gives the general flow-chart for image processing & applications in common astronomical images. Thus, the image was changed in the perspective of Lateral Geniculate Nucleus (LGN) using Difference of Gaussians (DoG) surmise [23] [26].

Finally the channel bank was handled on the LGN DoG created picture. To get the channel bank K-Means computation was used as a naturally possible clear Hebbian learning rule. Gabor stations are exhaustively utilized as basic low-level edge revelation channels and can be portrayed to be a reasonable Gaussian piece clashed with a sine channel. In Convolutional Neural Networks, a critical learning approach towards Image evaluation, Gaussian Gabor Filters/Kernels have been reliably utilized for low-level part portrayal and understanding like smoothening and Edge Detection [24][25].

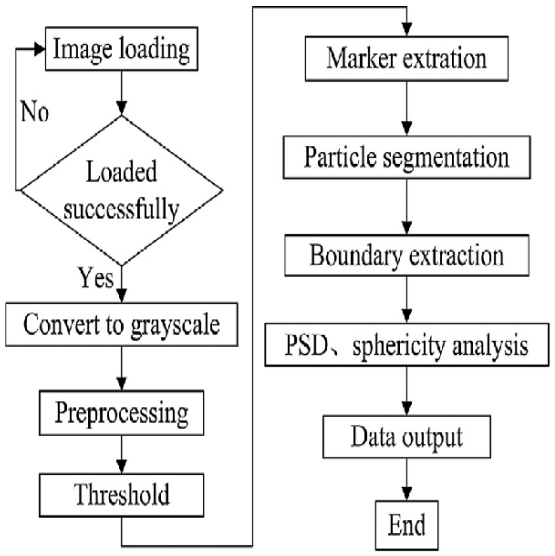


Fig. 10 : Flow-chart for image processing & applications [44]

15. Conclusions

In this review article, a brief informative description is given to the processing of images for astronomical needs and its applications in the space technology. The examination is intended to give the scholarly community and cosmologists a substantial extensive aide towards performing picture handling on cosmic pictures. It likewise characterizes the benchmark of the presentation of calculations equipped for being sent on cosmic pictures and can be utilized as a kind of perspective for future exploration in working on the logical pipeline of galactic picture handling. Future work incorporates characterizing and developing a computerized programming pipeline adequately effective to give insightful and factual outcomes dependent on a given info cosmic pictures.

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