International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 3 Issue 1, January - 2014

Machine Vision of Lunar Reconnaissance Orbiter Through MATLAB

Manas Arora
Mtech Student
Digital Comm.
Bbdniit

Neha Maurya
Mtech Student
Digital Comm.
Bbdniit

Poonam Pathak
Assistant Professor
Electronics &Comm.
Bbdniit

Abstract

Machine vision is a technology used by Lunar Reconnaissance Orbiter(LRO) for image capture, analysis and data collection about the Moon. This paper focuses on method of image processing and its matlab implementation

1. Introduction

Machine vision(MV) is the technology which employs methods to provide imaging-based automatic inspection and analysis for applications like automatic inspection, process control, and robot guidance in industry.{1,2] The scope of machine vision is very broad and is enhancing day by day[2,3,4].

In machine vision technology an image is obtained from imaging device and is processed by the machines. Basic methods employed for image processing are image compression and image segmentation. Image compression is a technique which reduces image size, PSNR value and number of pixels and W/L ratio is maintained same in order to increase the capacity of file storage. Image segmentation is another imaging process in which proper segments are selected to reconstruct the image which are less noisy and are close to object. In this method of image processing unlike in human chromosomes natural selection is done a composite image is formed by segments of different images taken of same object by LRO.

Both the techniques of image processing are also used in GPU technology and Genetic Algorithm which are used by LRO to communicate the data in the form of images to the earth station.

2. Methodology of machine vision

Basic steps in machine vision technology are:

2.1 Imaging

Conventional 2D visible light imaging is most common in LRO which is basic principle of MV include imaging various infrared bands[10] line scan imaging, surface 3D imaging, X-ray imaging[5].Imaging process is simultaneous over the entire image, making it suitable for moving processes [11].Triangulation is the most commonly used method for 3D imaging and are grid based and stereoscopic[12].

The imaging device either be separate from the main image processing unit or combined with a smart sensor[13,14]. In the independent processing unit imaging device the connection is made through specialized hardware or by a frame grabber or custom interface[15,16,17,18]. MV implementations is also capable of direct connections or Gigabit Ethernet interfaces[18,19].

2.2 Image processing

After an image is captured it is processed by the following methods :

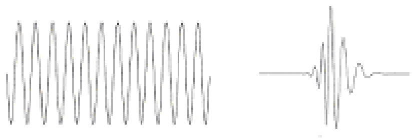
- Pixel counting: counts the number of light.
- Thresholding: converts an image with gray tones to simply black and white[23]
- Segmentation: Partitioning: a digital image into multiple segments to simplify[24]

Machine vision methodology defines the process of defining and creating solution of it[6,7] and is a technical process. In 2006 standardization of interfacing and configurations used in MV was defined which includes user interfaces, interfaces for the integration of multi-component systems .and automated data interchange[8].Blobs frequency represents optical targets for machining, robotic capture, or manufacturing failure in MV[25].MV basically includes image compression for image processing.

3. Image compression

Compression of an image taken by the Rover is a most efficient technique in MV technology in which W/L of the image, number of pixels and resolution of an image. In the rovers graphics nature of the image is maintained and memory constrains are changed. In image compression memory size of the image is changed such that available memory. The graphics layout of the image is modified in image compression by GPU technology and compression is obtained by transforming the image by using Wavelet transform. This transform transforms image into another form of representation. It does not change the information content present in the image. Wavelet Transform provides a time-frequency representation of the image [27].

The Wavelet transform involved uses small wavelets of finite energy and power of the wavelets is zero. Wavelets used in this transform are localized waves.



.

Figure 1: a WAVE and a WAVELET

Wavelet transform divides image into number of signals according to the window function and each signal to be analyzed by multiplying with a wavelet function .Output of the system using Wavelet transform depends upon width of the wavelets and depends tiing sequence and duration of the wavelets.

Nature of timing sequences of wavelets transform may be Continuous or Discrete. The window function of continuous wavelet transform from (1).

$$Xwt(\tau,s)=\frac{1}{\sqrt{|s|}}\int x[t].\psi*(\frac{t-\tau}{s}) \qquad (1)$$

Equation 2 gives window function of continuous wavelet transform.

$$Xwt(\tau,s)=\frac{1}{\sqrt{|s|}}\psi(\frac{t-\tau}{s}) \qquad (2)$$

The continuous wavelet transform is the sum over all time of scaled and shifted versions of the mother wavelet ψ. The coefficients in continuous wavelet transform are calculated from (3).

$$C(s,\tau)=\int f(t)\psi(s,\tau,t)dt \qquad (3)$$

in which τ is proportional to time information and s is proportional to inverse frequency information[33].

The Discrete Wavelet transform is calculated using above window function and respective transform function is (4).

$$y[n]=(x*g)[n]=\sum_{\infty}x[k]g[n-k] \qquad (4)$$

The Discrete Wavelet Transform (DWT), is based on sub-band coding and yields fast computation of Wavelet Transform[27].

In MV image compression 256 intensity levels or scales in which 0 is black and 255 are white are used. Each level is represented by an 8-bit binary number so black is 00000000 and white is 11111111[28].

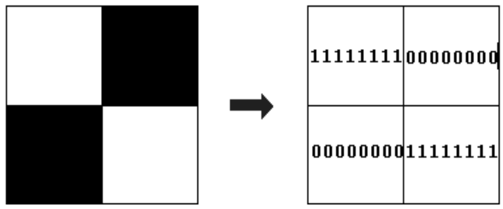


Figure 2: Intensity level of an Image

At the receiver end decompression is performed using inverse Wavelet transform (WT) and original image is obtained by (5).

$$x(t)=\int_0^\infty\int_{-\infty}^{\infty}\frac{1}{a^2}X_W(a,b)\frac{1}{\sqrt{|a|}}\overline{\psi}\left(\frac{t-b}{a}\right)dbda \qquad (5)$$

where $\overline{\psi}(t)$ is a dual function of $\psi(t)$.

4. Implementation in matlab

MV has image compression technique as the basic image processing technique which is implemented by using wavelet transform as the transforming technique. Wavelet transform is used as it is most efficient and speed of transformation is also high. Following commands are used in MATLAB for implementing:

for Machine Vision

1)*imshow*: displays image
2)*imsubstract*: substracts one image from another
3)*imwrite*: write image to graphics file
4)*imfinfo*: returns a structure containing fields of information about image
5)*colormap*: set and get color maps.
6)*ddencmp*: DeNoises the captured image
7)*getsnapshot*: acquires image
8)*preview*:displays the image before and after capturing.

for Image Compression (using WT)

1)*wavedec2*: multilevel 2-D decomposition
2)*wrcoef2*: reconstructs single branch coefficients
3)*idwt2*: performs 2D inverse wavelet transform

4)*waverec2*:multilevel 2D wavelet reconstruction
5)*wdcbm2*:thresholds for 2D wavelet transform

5. Outputs in matlab

MATLAB is an engineering tool which helps in understanding real world easily. In machine vision technology basic operation uncludes image acquisition and image processing which are implemented in matlab by using above commands.

Outputs for

5.1 Image acquisition

In this following two steps are done:

- Imaging device initialization
- Capturing of image

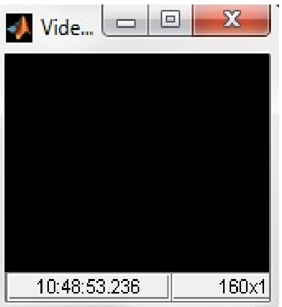


Figure 3:Imaging device initialization

Figure 4:Capturing of image

5.2 Image Processing

This includes image compression using matlab commands.The output after compression are:

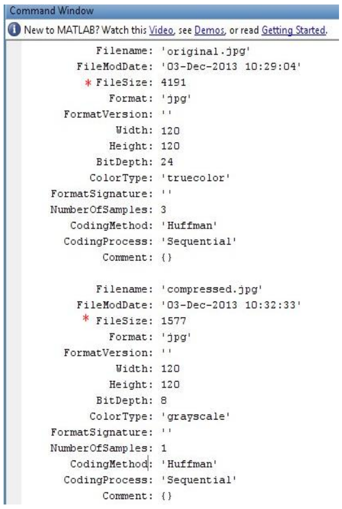


Figure5:Comparison of original and compressed images

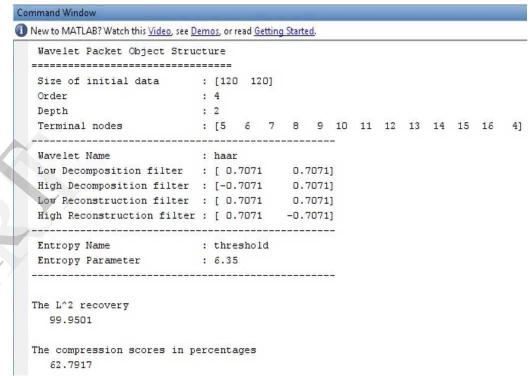


Figure 6:Wavelet packet object structure for image compression in matlab

6. Applications

MV technology has numerous applications starting from terrestrial to satellite and even on planet rovers.Terrestial applications include pattern recognition[25],barcode, data matrix and 2D barcode reading[25].Optical character recognition[25],Gauging/Metrology[25],Edge detection[25],multi-variable decision making[26] and filtering.In satellite applications MV is used in LRO where it performs color analysis,identify parts, products and quality from color, and isolate features using color.

7. Conclusion

Though the vast majority of machine vision applications ,it solves using 2D and 3D imaging. It is a method to to analyze an object without complex means.In short MV is a tool of analyzing object without touching it.

8. References

[1] Steger, Carsten, Markus Ulrich, and Christian Wiedemann "Machine Vision Algorithms and Applications. Weinheim" Wiley-VCH. p. 1. ISBN 978-3-527-40734-7,2008.

[2] Graves Mark,Bruce G."Machine Vision for the Inspection of Natural Products" Springer. p. 5,2003.

[3] Holton, W. Conard "By Any Other Name". Vision Systems Design1",2010

[4] Relf, Christopher G. " Image Acquisition and Processing with LabVIEW" 1.CRC Press,2004

[5] Turek, Fred D. "Machine Vision Fundamentals, How to Make Robots See". NASA Tech Briefs 35 (6): 60–62.29,2004.

[6] West, Perry "A Roadmap For Building A Machine Vision System ",p-p 1-35

[7] Dechow, David "Integration: Making it Work". Vision & Sensorsp-p 16–20,2009.

[8] Hornberg, Alexander (2006). Handbook of Machine Vision. Wiley-VCH. p. 709.ISBN 978-3-527-40584-8. Retrieved 2010-11-05

[9] Demant C., Streicher-Abel B. and Waszkewitz P. "Industrial Image Processing: Visual Quality Control in Manufacturing" Springer-Verlag. ISBN 3-540-66410-6

[10] Wilson Andrew "The Infrared Choice". Vision Systems Design 16 (4): 20–23.,2011

[11] West, Perry High Speed, Real-Time Machine Vision CyberOptics, pages 1-38

[12] Murray, Charles J ,"3D Machine Vison Comes into Focus".Design News,2012.

[13] Belbachir, Ahmed Nabil, ed.. Smart Cameras. Springer. 2009

[14] Dechow, David,. "Explore the Fundamentals of Machine Vision: Part 1". Vision Systems Design 18 (2): 14–15. Retrieved 2013-03-05.

[15] Wilson, Andrew,"CoaXPress standard gets camera, frame grabber support". Vision Systems Design. 2011.

[16] Wilson, Dave "Cameras certified as compliant with CoaXPress standard". Vision Systems Design.2012

[17] Davies, E.R."Machine Vision - Theory Algorithms Practicalities (2nd ed.). Harcourt & Company 1996

[18] Dinev, Petko "Digital or Analog? Selecting the Right Camera for an Application Depends on What the Machine Vision System is Trying to Achieve".2009.

[19] Wilson, Andrew "Product Focus - Looking to the Future of Vision".Vision Systems Design 16,2011.

[20] Davies, E.R."Computer and Machine Vision: Theory, Algorithms, Practicalities (4th ed.). Academic Press. pp. 410–411,2011

[21] http://research.microsoft.com/en-us/people/fengwu/depth-icip-12.pdf

[22] R.Morano,C.Ozturk,R.Conn,S.Dubin,S.Zietz,J.Nissano, "Structured light using pseudorandom codes",IEEE Transactions on Pattern Analysis and Machine Intelligence 20 (3)(1998)322–327

[23] Demant C., Streicher-Abel B. and Waszkewitz P."Industrial Image Processing: Visual Quality Control in Manufacturing" Springer-Verlag. p. 9,1999.

[24] Linda G. Shapiro and George C. Stockman): "Computer Vision", pp 279-325, 2001

[25] Demant C., Streicher-Abel B. and Waszkewitz P. " Industrial Image Processing: Visual Quality Control in Manufacturing". Springer-Verlag. p-p 95-108,1999

[26] Turek, Fred D. (March 2007). "Introduction to Neural Net Machine Vision". Vision Systems Design 12 (3). Retrieved 2013-03-05.

[27] Yamanaka, O. ,Yamaguchi, T. , Maeda, J. ,Suzuki, Y. "Image compression using wavelet transform and vector quantization with variable block size" Soft Computing in Industrial Applications, 2008. SMCia '08. IEEE Conference ,June 2008

[28] Grgic,S. Kers, K., Grgic, M. "Image Compression using Wavelets" ,Industrial Electronics, ISIE '99. Proceedings of the IEEE International Symposium