High Performance Computation and Pattern Recognition Techniques for Detecting Lunar Craters Using Satellite Image- A Review

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***Abstract*— Craters, one of the utmost noteworthy landforms of the lunar surface, have been extensively researched because they offer us the revision of relative and absolute surface chronologies, erosional progressions, and origin evolution of lunar surface. The modern research emphases on identification of craters in terms of its characteristics and detection of these visual sorts of the moon to regulate asafe landing site for an astral lander. Craters seem in enough mass on most planetary system forms of interest and also known as a stable in advent or shapes over stretch or under diverse conditions and environs. Currently, there are a lot of ongoing researches mainly in craters recognition and ocular triangulation systems for the moon but still using a complex and similar approach. Hence, this paper reviewsvarious algorithms involved for identifying various types of craters, which will highly be influential for any future research work. In addition to this, this paper will also have a brief scenario about high performance computing in pattern recognition which will effectively help in the process of detecting the craters in much faster and effective way, totally autonomous on the algorithm chosen. This paper describes briefly about the parallelization of object recognition to identify several lunar craters parallel with high synchronization processor speed.**

Keywords*— high performance computation, pattern recognition, parallelization, craters, oblique craters.

I. INTRODUCTION

Impact cratering is a vivacious progression in the Solar System, and on rock-hard planetary builds sway cratering may be the most conspicuous land materializing process. The impact crater development process results in a circular shape of fresh craters, except for sways at low angles. Hyper velocity collisions of asteroids onto planetary bodies have calamitous effects on the target rocks through the course of shock metamorphism. The resulting topographies, impact craters, are circular depressions with a strident rim bounded by an ejecta blanket of erratically

shocked rocks. With cumulative impact energy, the inner crater nook can preserve multifaceted morphologies including terraced barriers, central uplifts, and melted rocks. The lack of attrition due to the deficiency of water or an atmosphere makes the Moon the seamless target to study impact crater procedures, in particular the distribution of exceedingly shocked materials within impact craters of various sizes.

This paper discusses fleetingly about the various algorithms involved in detecting lunar craters which goes like detecting small craters, random craters, complex craters by using algorithms like maximum likelihood, template matching, Hough transform, support vector machines, continuously scalable template models, morphology gradient technique. Each and every technique mentioned above will be discussed intricately on how to contrivance this methods and will also discuss about the results obtained. This paper will also discuss in detail about the high performance computing technique which will improve the previously obtained results and also about the object recognition [32].

II. METHODS FOR DETECTING THE LUNAR CRATER

The methods involved by the researchers are reviewed below under each section.

A. Morphological Crater Detection Algorithm

Identification of craters in terms of its physiognomies and detection of these chromatic topographies of the moon to regulate a safe arrival site for a lunar lander can be done with the help of the morphological crater detection algorithm. This [1], was proposed using craters as breakthroughs for celestial navigation purposes because this arithmetical model grants a vigorous detection under miscellaneous lighting conditions. Moreover, craters seem in enough concreteness on most planetary system bodies of concern and also known as an impartially stable in form or shapes over time or under diverse conditions and situations. These superior features make them a fitting type of milestone to observe. To part from this curb, the author decides to construct a simple algorithm for identifying craters on the lunar surface which will perceive the craters based on two important dimensions that are the distance and angle measurements. The leads of using this approach are its expediency fast recognition can be used advance in ellipse rebuilding algorithm to determine the position and alignment of the crater. This paper discussed the method of engaging MATLAB and image dispensation contrivance on an optical image equally well as the morphological image recognition rudiments. In accumulation, some geometrical prognosis investigation in reconstructing an ellipse as a disc will be gauged in directive to obtain the alignment of the disc (crater) for sovereign optical navigation system.

B. Geography- Based Craters Recognition Algorithm

Many claims in lunar and planetary science necessitate vigorous crater detection algorithms (CDAs). The paper [2], Presents a unique hybrid CDA which exploits the topography renovated from optical images and our previously established topography-based CDA. The projected CDA is applied to two Chandrayaan-l M3 ocular images and one designated region of Lunar Scouting Orbiter WAC global ocular image mosaic. The general approach consists of: renovation of topography from ocular images; rectifications of brightness and contrast of used ocular images (this step is mandatory for manual corroboration of crater-candidates before enclosure into the resulting catalogue); and handling by topography-based CDA. In addition, the combined topography-based CDA has been utilized for the assessment of the initial topography reconstruction algorithm, and successive improvements. With such an attitude, they established that geography centered CDA, furthermoreenhanced using novel crater shape-based exclamation way, can be used: with geography refined from ocular images; and during succeeding enhancements of the topography renovation algorithm [2]. Experimental calculation of the proposed CDA is done by handbook corroboration of crater-candidates and cataloguing in the previous LU60645GT catalogue. The estimation has shown that the anticipated CDA was used efficaciously for categorization of 3570 lunar craters, which are effectively all visible craters from the three designated regions. Associated result is the new LU64215GT index of 64 215 Lunar craters, which is presently the most complete index of Lunar craters.

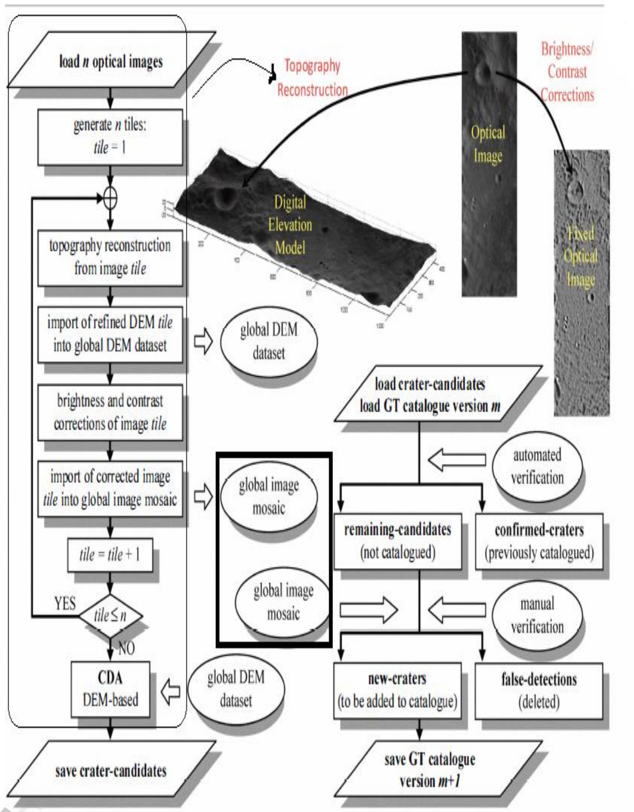

Figure 1. Schematic flow diagram of the projected hybrid CDA (left); two major steps in image processing (topography renovation, brightness improvements) - top right. (Modified after G. salamunnicar).

C. Spontaneous Feature Extraction

With each new terrestrial mission, the volume of attained data ominously increases. Different types of statistics are being composed, i.e., multitemporal, multimodal, and high-fidelity images, and need to be examined. Therefore, image cataloging is a crucial task to mutually exploit, assimilate, or relate all these diverse data. Extraction of longitudinal features in the images, is a critical introductory step in the image cataloging process. Furthermore, feature abstraction can be significant for further scrutiny of the data.

In ensuing work [3], in order to inevitably detect craters on Mars, the authors projected an amalgamation of template matching, edge detection, and supervised neural network-based structures for the gratitude of false positives. In a diverse approach, Martins et al. [4] adopted a supervised enhancing algorithm, which was initially developed by Viola and Jones [5] in the framework of face discovery, to identify craters on Mars. In [6], the authors presented a different approach for crater recognition in panchromatic planetary images. The method in [6] is based on using accurate morphology for the uncovering of craters and on supervised machine learning practices to distinguish between objects and false alarms. Other typical ellipsoidal structures in planetary images are signified by rocks. The main influence of this work is a novel unsubstantiated approach for feature abstraction on planetary images, aimed at mining curvilinear structures, pertinent for this typology of images as an archetypal model for craters and rocks. In particular, the planned approach is based on a novel grouping of robust image dispensation techniques such as, the Hough transform, the Canny operator and the watershed. Moreover, the method allows not only locating the features but also restructuring their shape.

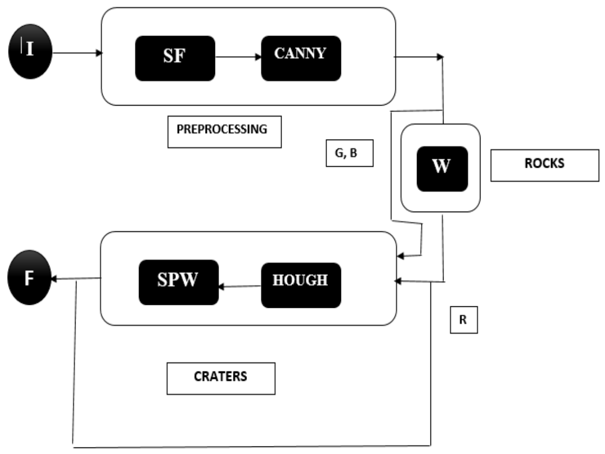

Figure 2.Topographic construction.

D. Biologically Motivated Archetypal For Crater Discovery [6].

Crater detection from panchromatic images has its inimitable challenges when matching to the old-fashioned object detection tasks. Craters are abundant, have large assortment of sizes and consistencies, and they unremittingly merge into image credentials. Using traditional feature assembly methods to define craters cannot well personify the diversified appearances of craters. They are steadily enlightening the surreptitious of object acknowledgement in the primate's visual cortex. Biologically motivated features, designed to caricaturist the human cortex, have achieved great recital on object detection delinquent. Therefore, it is time to reexamine crater detection by using biologically motivated features. In this paper[6], they represented crater images by exploiting the C1 units, which relate to intricate cells in the visual cortex, and pool over the S1 units by consuming a maximum maneuver to standby only the extreme response of each indigenous area of the S1 units.

The topographies engendered from the C1 units have the trademarks of size invariance and position invariance. They further quote a set of amended Haar topographies on each C1 map which comprehend gradient grain information. They apply this geologically inspired based Haar feature to crater detection. Because the feature erection process requires a set of geologically inspired conversions, these features are rooted in a high aspect space. We apply a subspace erudition algorithm to find the inherent discriminative subspace for exact cataloguing. Trials on Moon impact crater dataset show the dominance of the anticipated method.

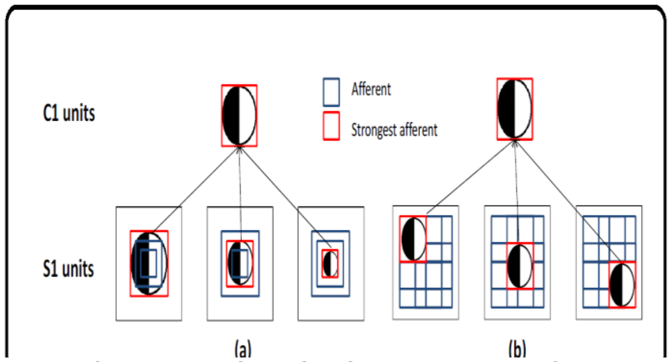

Figure3. The process to realize scale and position invariance at the intricate (C1) cells for one crater image: (a) Sturdiest afferent from diverse gauges fed into the C1 units to attain the gauges invariance (b) The C1 units pool over sturdiest afferent according to diverse pooling ranges to attain position invariance.(modified after [6]).

III. HIGH PERFORMANCE COMPUTING

High Performance Computing (HPC) is the lately advanced technology in the ground of computer science, which progressed due to increase in demands for treating speed. HPC brings together lots of technologies like computer architecture, procedure, agendas and system software under one awning to solve advanced composite problems swiftly and efficiently [31]. This equipment emphases on emerging and executing methods like cluster processing, parallel processing and distributed processing for deciphering glitches. Parallel processing is an approach to increase the rate of set of data which is processed by treating diverse parts of the statistics at the same time [11]. Contrasting other procedures where data in recorded in memory system in a period by period manner, distributed processing uses parallel processing on multiple machines, where data is spread to all parts of the memory system at once. In cluster computing CPUs are hooked up through high speed internet connections to a central server which gives each of them numerous task [11]. With the progression of satellite remote sensing technology we are getting high spatial, spectral resolution images with anenormous data available. But glitches occur when remote sensing image processing speed drops far behind which means that ample data cannot be translated into useful information in time. Recently, application of HPC technology is getting more importance in remote sensing research work. The utilization of HPC systems in remote sensing applications has become more and more widespread in recent years [14]. HPC is able to progress the computing speed to anexcessiveamount in enormous data processing, which makes itself an effective way to solve the problem of dispensation efficiency in remote sensing data. This paper will describe various techniques and methods of High Performance Computing for remotely sensed satellite image processing and

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 3 Issue 2, February - 2014

analyzing. The following sections briefly describe the above mentioned methods.

1. Parallel Computing

Parallel computing is a system of calculation in which countless calculations are carried out simultaneously [15] operating on the source that enormousglitches can often be divided into smaller ones, which are then solved concurrently ("in parallel"). There are several diverse forms of parallel computing: bit-level, instruction level, data, and task parallelism. Parallelism has been employed for several years, predominantly in high-performance computing, but importance in it has grown latterly due to the physical limitations preventing frequency scaling.[16] As power consumption (and repeated heat generation) by computers has become anapprehension in recent years,[17] parallel computing has become the prevailing paradigm in computer architecture, predominantly in the form of multicore workstations.[18] Parallel computers can be unevenlycategorized according to the level at which the hardware supports parallelism, with multi-core and multi-processor computers having multiple dispensationessentials within a solitary machine, while clusters, MPPs, and grids use several computers to work on the same task. Specialized parallel computer architectures are sometimes used alongside traditional processors, for accelerating specific tasks. Parallel computer programs are more difficult to write than sequential ones[19] because concurrency introduces several new classes of potential software bugs, of which race conditions are the most common. Communication and synchronization between the different subtasks are typically some of the greatest obstacles to getting good parallel program performance. The maximum possible speed-up of a single program as a result of parallelization is known as Amdahl's law**.**

A. Parallel Computation In Object Recognition

The parallel computation for object recognition is developed for detection the object with the feature extraction. The feature extraction involves the following steps 1. Selection of the candidate key point on a hessian matrix in the scale space and 2. Taylor expansion is utilized to obtain accurate location. The hessian matrix is computed from the second order Gaussian blurred image sampled in a parallel sequence.

Using the pixel details the pyramid structure is set and they are fed as individual thread to the hessian matrix by categorizing it as M and N rows of pixels. Pixels are grouped into several blocks and each blocks are hence processed in each processor.

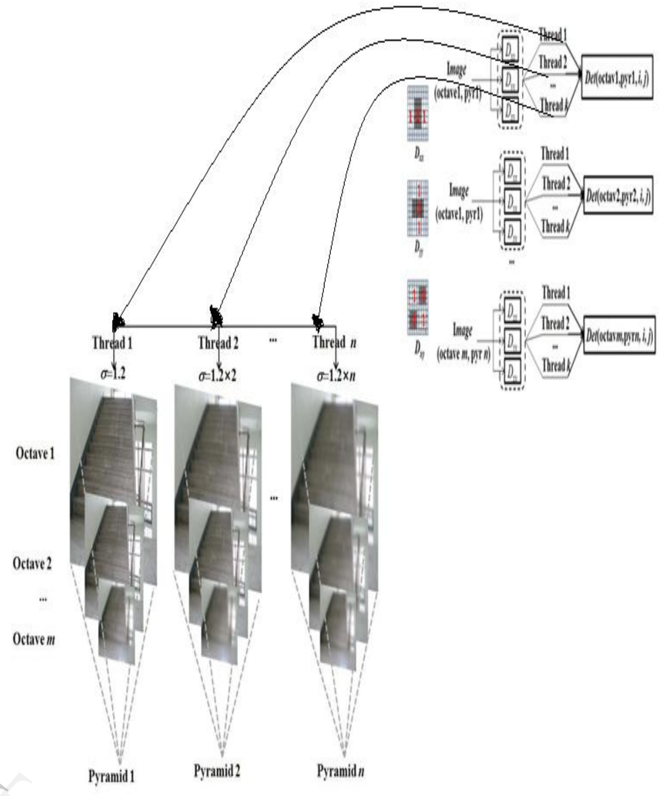

Figure 4. Parallel configure-tionfor key point on hessian matrix(modified after [16]).

IV. CONCLUSION

From the above discussion the cognitive process of supposing can be derived in such a way, that the various algorithms being used in the present research scenario are very omnipresent with which combination of several such algorithms can be used for more accurate and obvious results. Approaches conversed above are some of the practices that are the subsection of High Performance Computing (HPC) practices that are being hired today to progression large expanses of statistics. Thus diverse tactics can be hired for diverse projects. Parallel dispensation is chiefly useful in schemes that necessitate multifaceted reckonings. Parallel dispensation context can be pragmatic to most image fusion procedures and hyperactive spectral image dispensation based on neural designs and morphological prototypical. By parallelization the image processing field experiences a drastic advancement with accurate results. Multiple threads for various segments of the algorithms fragmented gets processed parallel so that the delay in the pattern recognition will be totally minimized and processed in real- time. Thus, more research work entails on satellite data dispensation and analyzing over HPC platform for getting a boosted and fast output for several remote sensing claims.

ACKNOWLEDGMENT

Authors are grateful to VEL Tech Dr. RR & Dr. SR technical university for their support and encouragements. Authorsextending their gratitude to Ms. Kavitha kalidass, ACTS, C-DAC, Pune for her moral support.

REFERENCES

[1] Nur Diyana Kamarudin, Siti Noormiza Makhtar, Hizrin Dayana M.Hidzir "Craters Detection on Lunar" Department of Electrical and Electronic Engineering, Faculty of Engineering, Proceeding of the 2011 IEEE International Conference on Space Science and Communication (Icon Space) 12-13 July 2011, Penang, Malaysia.

[2] Salamuniccar G,Loncarie S, Grumpe A, Wohler C "Hybrid Method for Detection of Lunar Craters Based on Topography Reconstruction from Optical Images"7th International Symposium on Image and Signal Processing and Analysis (ISPA 2011) September 4-6, 2011, Dubrovnik, Croatia.

[3] Kim J. R,Muller J.P, van Gasselt S, Morley J. G, and Neukum G, "Automated crater detection, a new tool for Mars cartography and chronology," Photogramm. Eng. Remote Sens., vol. 71, no. 10, pp. 1205–1217, Oct. 2005.

[4] Martins R, Pina P, Marques J. S, and Silveira M, "Crater detection by a boosting approach," IEEE Geosci. Remote Sens. Lett. vol. 6, no. 1, pp. 127–131, Jan. 2009.

[5] Viola P and Jones M, "Robust real-time face detection," Int. J. Comput. Vis., vol. 57, no. 2, pp. 137–154, May 2004.

[6] Urbach R and Stepinski T. F, "Automatic detection of sub-km craters in high resolution planetary images," Planet. Space Sci., vol. 57, no. 7, pp. 880–887, Jun. 2009.

[7] WIKI. (2013). http://wiki.answers.com/Q, Accessed. June, 2013.

[8] Peleg D. (2000).Distributed Computing: A LocalitySensitive Approach, SIAM, ISBN 0-89871-464-8:pp. 10. https://en.wikipedia.org/wiki/Distributed_computing. Accessed, June, 2013.

[9] Ghosh and Sukumar (2007). Distributed Systems – An Algorithmic Approach. Chapman & Hall/CRC. https://en.wikipedia.org/wiki/Distributed_computing. Accessed, June, 2013.

[10] Lee, C. A., Gasster, S. D., Plaza, A., Chang, C. I., & Huang, B. (2011). Recent developments in high performance computing for remote sensing- A review. IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing. 4.3: 508-527.

[11] Barry Wilkinson B. and Michael Allen (2002). Parallel Programming. China Machine Press. www.cse.ucsc.edu/classes/cmpe113/Fall02/slides1.4.ps.

[12] Hangye Liu, Yonghong Fan, Xueqing Deng, Song Ji. (2009). Parallel Processing Architecture of Remote Sensed Image Processing System Based on Cluster. IEEE Image and Signal Processing 09. CISP '09. 2ndInternational Congress. http://ieeexplore.ieee.org/xpl/articleDetails.jsp?arnumber =5300938.

[13] Yang J.H., J.X. Zhang, Li Haitao, Sun Yushan, Pu Pengxian.(2010). Pixel Level Fusion Methods for Remote Sensing Images: a Current Review, Technical Commission VII Symposium, Vienna, Austria. pp.680. http://www.isprs.org/proceedings/XXXVIII/part7/b/pdf/680_XXXVIII-part7B.pdf.

[14] Alper A G., Adnan O, Meric Y., Sedef K P., Serdar B., and Mesut K. (2013). Remote Sensing Data Fusion Algorithms with Parallel Computing. http://academia.edu/3266480/Remote_Sensing_Data_Fusion Algorithms with Parallel Computing. Accessed June, 2013.

[15] Gottlieb, Allan; Almasi, George S. (1989). *Highly parallel computing*. Redwood City, Calif.: Benjamin/Cummings. ISBN 0-8053-0177-1

[16] S.V. Adve et al. (November 2008). "Parallel Computing Research at Illinois: The UPCRC Agenda" (PDF). Parallel@Illinois, University of Illinois at Urbana-Champaign. "The main techniques for these performance benefits – increased clock frequency and smarter but increasingly complex architectures – are now hitting the so-called power wall. The computer industry has accepted that future performance increases must largely come from increasing the number of processors (or cores) on a die, rather than making a single core go faster."

[17] Asanovic et al. Old [conventional wisdom]: Power is free, but transistors are expensive. New [conventional wisdom] is [that] power is expensive, but transistors are "free".

[18] Asanovic, Krste et al. (December 18, 2006). "The Landscape of Parallel Computing Research: A View from Berkeley" (PDF). University of California, Berkeley. Technical Report No. UCB/EECS-2006-183. "Old [conventional wisdom]: Increasing clock frequency is the primary method of improving processor performance. New [conventional wisdom]: Increasing parallelism is the primary method of improving processor performance ... Even representatives from Intel, a company generally associated with the 'higher clock-speed is better' position, warned that traditional approaches to maximizing performance through maximizing clock speed have been pushed to their limit."

[19] Hennessy, John L.; Patterson, David A., Larus, James R. (1999). "Computer organization and design: the hardware/software interface (2. ed., 3rd print. Ed.)". San Francisco: Kaufmann. ISBN 1-55860-428-6.

[20] Yang J.H., J.X. Zhang, Li Haitao, Sun Yushan, Pu Pengxian.(2010). "Pixel Level Fusion Methods for Remote Sensing Images: a Current Review", Technical Commission VII Symposium, Vienna, Austria. pp.680.

[21] Alper A G., Adnan O, Meric Y., Sedef K P., Serdar B., and Mesut K. (2013). "Remote Sensing Data Fusion Algorithms with Parallel Computing". http://academia.edu/3266480/Remote_Sensing_Data_Fus ion Algorithms with Parallel Computing.

[22] Yang Jinghui, Zhang Jixian (2012). "A Parallel Implementation Framework for Remotely Sensed Image Fusion". ISPRS Annals of the Photogrammetry, Remote Sensing and Spatial Information Sciences, Volume I-7, 2012 XXII ISPRS Congress, 25 August – 01 September 2012, Melbourne, Australia.

[23] Yuhas R.H., Goetz A.F. And Boardman J.W. (1992). "Discrimination among Semi-Arid Landscape End Members Using Spectral Angle Mapper (SAM) Algorithm". Summaries of the Third Annual JPL Airborne Geosciences Workshop, Vol.1, Pasadena, CA: JPLPublication.pp.147149.

[24] Chikr M E Mezouar, N.Taleb, K.Kpalma and J. Ronsin (2011). "An HIS Based Fusion for Color Distortion and Vegetation Enhancement in Ikonos Imagery". Geosciences And Remote Sensing, IEEE Transactions on, Vol.49, No.5.pp.1590602.

[25] SC. (2013) Remote sensing University Lecture note.http://www.sc.chula.ac.th/courseware/2309507/Lecture/remote18.html

[26] Smit M., Garegnani J, Bechdol M and Chettri S. (2000). "Parallel Image classification on HIVE". http://ieeexplore.ieee.org/xpls/abs_all.jsp?arnumber=953 601&tag=1.

[27] Kato Z., Zerubia J., Berthod M. (1999). "Unsupervised parallel image classification using Markovian models". Pattern Recognition 32 (1999) 591Ð604, p.591-602. http://www.inf.u-szeged.hu/~kato/papers/pattrec99.pdf.

[28] Hillis W.D. (1985). The Connection Machine. MIT press NewYork.http://www.inf.uszeged.hu/~kato/papers/pattrec99.pdf.

[29] TMC, Thinking Machines Corporation, Cambridge, Massachusetts, Connection Machine Technical Summary (1989).Version5.1Ed.http://www.inf.uszeged.hu/~kato/papers/pattrec99.pdf.

[30] Kato Z, Berthod M, Zerubia J., A. (1996). "Hierarchical Markov random Field model and multi-temperature annealing for parallel image classification, Compute. Vision Graphics Image Process. Graphical Models Image Process". 58:1837.http://www.inf.uszeged.hu/~kato/papers/pattrec99.pdf.

[31] Bhojne M, Chakravarti A, Pallav A & Sivakumar V. (2013), "Parallel computing in remote sensing data analyzing & processing, International Journal for Computer Application Technology and Research", Vol. 2 (4), pp 424-430

[32] Saranyaraj. D. " The Virtual Guide For Assisted Tours Using Context Aware system" IEEE Digital Explore, Signal Processing Image Processing & Pattern Recognition (ICSIPR), 2013 International Conference.