

FPGA Implementation of Image Acquisition in Marine Environment

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Abstract

Image acquisition is one of the major challenges in the marine environment. A lot of research is going in this field to acquire, process and monitor the images captured in an ocean. In the olden days, Image capturing was difficult because of non availability of specially designed cameras to capture under water images. But due to advances in technology lots of advance cameras are available which can able to capture images with high resolution. Critically we also need a processor to process the data which is in the form of image. The captured image has to be processed for its various factors so that the data obtained from the images can be able to predict the ocean currents, flora and fauna inside the ocean. A server with high capacity is to be erected if the images are to be transferred in real time and the frequency of capturing images is also very high. This research paper is concentrated on image acquisition and image processing to get the inside details of a marine environment. This can also be used for military purpose for surveying submarines.

Keywords: Image Acquisition, FPGA, Image Processing.

1. INTRODUCTION

In the past decade, FPGA has grown over various applications. It is a simple chip which can be grown over to accommodate various algorithms. It is used for implementing various applications. It is flexibly used as a reconfigurable platform for any application because of its versatile hardware. It is well suited since the signals obtained can be processed in parallel. Also it can be reconfigured any number of times for programming. High computational task can be done in an easier manner. It is an apt choice for processing of digital image signals. It can be incorporated as an

embedded system, so that computation also can be done in any real time environment. The algorithm as well as the architecture can be designed using FPGA. The challenge is now fully lies with capturing the image since the computation can be handled by FPGA properly. As far as image acquisition is concerned, the high quality cameras can be able to acquire the image in a prescribed resolution. The research work is now concerned on interfacing the camera with FPGA and manipulation of data. The data which is in the form of image may contain different parameter which has to be extracted and to be optimized for processing.

In space, the images are captured using camera which are incorporated in the satellite and further used for processing. In that case a common field programmable gate array is needed to connect it to sensors. The sensor may be a camera. The data from the sensor has to be taken to a processor and processor in turn performs real time manipulation of received data. The manipulation purely depends on the quality of the image captured by the camera. The problem in marine environment is that it is constantly exposed to salt water which will make the camera vulnerable and the lifetime also gets worsened day by day.

The wear and tear of camera has to be considered in the process and the need of an algorithm which can be able to process the data has to be developed. An algorithm is a set of procedures which has to be changed based on the type of image. Based on the image, the algorithm must change accordingly. Adaptive nature of the algorithm will ensure better processing of signals. The algorithm also must suit to work in accordance with FPGA.

Processing of images taken underwater requires lot of improvements to analyze the data. The challenges are image quality, resolution and contrast level. Because of light propagation all these factors may get affected since the medium of propagation is light. So an efficient algorithm is needed for processing these images. Light attenuation is one of the problems that affect the visibility to capture image. It can be able to capture up to certain meters without any attenuation. If the water is muddy, then it will be a major threat to capture image. The attenuation is due to dispersion and absorption of light energy in the medium. The attenuation also gets varied when the medium is getting varied by natural means. It also depends on the material getting dissolved in water and floating matter. However due to advancement in technology, synthetic lights are also used while capturing images. But the synthetic lights are not uniform all over the penetrating medium and hence make things complex. So the distance between camera and image played a major role in image acquisition.

The particles which are floating in the sea will cause blur images and also changes the colors of the image. So along with the capturing the image, image also has to be enhanced for removing the extra artifact. Use of filter is an appropriate option to convert a blurred image into a better image for further processing. The processing of the images for better clarity is called as image enhancement and lot of algorithms are to be tested for image enhancement. Histogram equalization is also used to eradicate attenuation, dispersion and light effect. Sometimes this method may not be able to remove the noise and a low pass filtering has to be applied to get an enhanced image.

2. RELATED METHOD:

[1] have developed an image and video processing platform for capturing real time images and implemented using FPGA. The programming is done with the help of programming language C. The program is then compiled and implemented using FPGA. Here the processing of image is done with the help of C Program. [2] developed a Laser Image detector. Here an algorithm is used based on Zernike moments and this technique was used for planes to monitor the cloud movement.[3] presents a real time multi object tracker. In this technique, 3 images or objects can be tracked in parallel by using various algorithms for each object. The algorithm can be changed accordingly based on the object. The algorithm is incorporated with the help of FPGA's. [4] presents a hardware model based on color and gray scale images. Image enhancement is done with the help of FPGA in video processing and histogram equalization is also tried out. The images processed in this technique were either taken in dark environment or varied lighting area.

[5] proposed fast prototype platform using FPGA. The hardware is interfaced with peripheral device. Here all the real time data were taken and processed using a computer. [6] proposed a new architecture for processing real time signals. The architecture is based on FPGA. The inputs are taken with the help of sensors and the sensors are connected to the FPGA. The controlling part is also done with the help of the hardware. A parallel port is used to exchange the image between computer and FPGA.[7] implemented a method to capture video and then it is processed using Xilinx FPGA board. The video signal is digitized and displayed in the computer.

[8] described how to capture real time linear image and process using a FPGA NexysII. The Proposed system is connected to computer via USB and it is mainly meant for education purpose.GUI is used to connect to FPGA for data transfer and communication purpose. [9] described a new method of capturing video in a large range. Stereo depth measurement is made to capture the image using FPGA. This method provides modification in the input video signal and provides sub pixel disparities of images in a longer range. [10] presents a reconfigurable parallel architecture based on video rate. This can be mainly used for computer vision applications. The architecture is modeled using 2D array and implemented using FPGA. The processors are connected by systolic array. Pipelining is used to handle multiple images and to manipulate parallel images. It can be used for applications where pre processing is required since it has to cover a wide range of applications. The information exchange can be done in terms of pixel by pixel.

[11] deals with using new FPGA for 2D and 3D images. It performs operations like image restoration and image denoising. [12] proposed FPGA with pipeline structure. It uses simple lookup tables rather than high end hardware for complex calculations. It goes by the option of using low cost hardware. Omni directional images are mostly manipulated in this method. [13] proposed a new technology for image enhancement using hardware. Here a simple contrast enhancement scheme named Adaptively Increasing the Value of Histogram is proposed using histogram. The contrast is adjusted for image enhancement and an effective method is used to control the

contrast.[14] uses scanning at higher frequency using FPGA to solve the image cross linking problem. The images were verified by scanning and it is taken for processing. [15] proposed a method using focal-plane image processing.

Two important areas are identified. Image reorganization [23] –[26] is used for compressing the image and half toning the image. The image reorganization processor is a method of grouping CCD circuit and CCD imager. The half-toning chip consists of frame transfer imager, a pipeline register, and comparator Circuit.

[16] proposed an architecture using focal-plane optoelectronics. It also employs SIMD processor for computation purpose. It computes real time signals of various images.[17] used SIMPil design for image analysis. It is designed using pixel processor combined with SIMD. In this lot of sensor arrays were used in parallel with computation layer. Multiple processing elements were used for effective computation. [18] proposed image processing using cloud environment. The extracted images are sent to cloud and matched before going for computation. [19] proposed an new method based on image denoising. The image stored in the cloud is compared with noisy image obtain from the camera. Noise removal is done based on the correlation between the two images.

3. PROPOSED SYSTEM

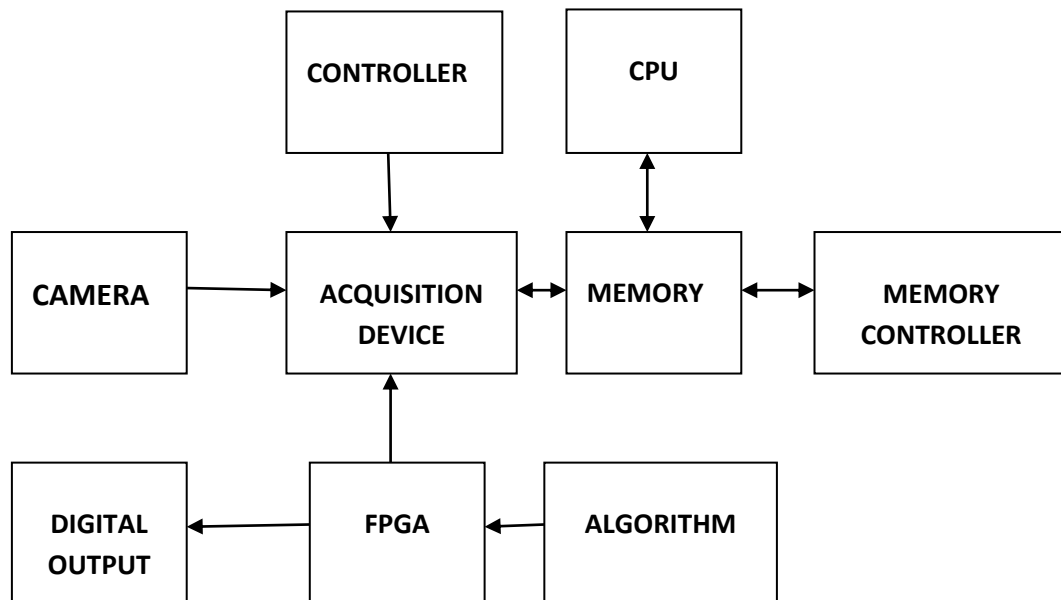


Figure 1: Architecture

Figure 1 show the proposed method, in which the camera captures the real time image in the marine environment. The image captured is called the image acquisition device which has to be designed based on the conditions of the sea. The acquisition device is purely based on penetration level, attenuation due to light, dispersion, floating

particles etc..., The image captured is stored in a memory device and it is controlled by a controller. The memory controller maintains the images and blurred images are removed from the main memory. The CPU performs the computation in order to get the required parameters from the images with the help of an appropriate algorithm. Based on the image resolution the algorithm also has to be adapted for effective retrieval of parameters. FPGA plays a major role in processing the images along with the help of an algorithm. The algorithms can be varied based on the image quality and FPGA can able to accommodate the various algorithm because of its robust nature.

The processed image is then sent to the digital output. A feedback loop can be incorporated if the image quality is not up to the level. The image can be again given to the FPGA and again the algorithm has to be adapted to enhance the quality of the image. The proposed system helps in able to produce clear images for extracting the parameters for further investigation.

4. CONCLUSION

The proposed method provides higher efficiency in terms of capturing the image and processing the image. The use of FPGA plays a vital role in increasing the computation in a parallel manner. The image acquisition is done either with the help of professional cameras meant for marine environment and the captured real time images are fed to FPGA which will manipulate to extract the needed data. Since FPGA has high computation capacity and the rotation of algorithm helps to adapt to the images obtained. This method will prove to be an alternative when compared with present available methods.

REFERENCES

- [1] Srinivas K.,2007,“Implementation of FPGA in the design of embedded systems”, National Institute of Technology, May. p.78.
- [2] Monmasson E., Cirstea MN.,2007, “FPGA design methodology for industrial control systems—a review’, Institute of Electrical and Electronics Engineers (IEEE) Transactions on Industrial Electronics. Aug, 54(4):1824–42.
- [3] Chang TN., Cheng B., Sriwilaijaroen P.,2006, “Motion control firmware for high-speed robot systems”, Institute of Electrical and Electronics Engineers (IEEE) Transactions on Industrial Electronics. Oct, 53(5), 1713–22.
- [4] Ranganathan O., Rasheed.,2013,“Design and development of camera interface controller with video pre-processing modules on FPGA for MAVS”, SASTECH Journal, Apr,12(1),9–14.
- [5] Praveen vanaparthi., Sahitya.G., Krishna Sree., and Dr.C.D.Naidu.,2013,”FPGA implementation of image Enhancement algorithms for biomedical Image processing”, International Journal of Advanced Research in Electrical,Electronics and Instrumentation Engineering

- , Vol. 2, Issue 11.
- [6] Deepesh Prakash Guragain., Pramod Ghimire., Kapil Budhathoki.,2018, "Implementation of FPGA Based Image Processing Algorithm Using Xilinx System Generator", Volume: 05 Issue: 01
 - [7] Ankita gupta., Himanshu Vaishnav., Himanshu Garg., "Image Processing using Xilinx System Generator (XSG) in FPGA", Volume II, Issue IX.
 - [8] Fahad Siddiqui 1., Sam Amiri., Umar Ibrahim Minhas., Tiantai Deng., RogerWoods.,
- Karen Rafferty and Daniel Crookes., 2019, "FPGA-Based Processor Acceleration for Image Processing Applications", J. Imaging 5, 16, doi:10.3390/jimaging5010016
- [9] C.Kalyana Sundaram., M.Elango., P.Marichamy.2014, "Implementation of Image Processing Algorithm Using Partial Dynamic Reconfiguration in FPGA", International Journal of Innovative Research in Science, Engineering and Technology, Volume 3, Special Issue 3.
 - [10] Avinash G. Mahalle., A. M. Shah., 2017, "FPGA Implementation of Gradient Based Edge Detection Algorithms", International Journal of Innovative Research in Computer and Communication Engineering Vol. 5, Issue 5
 - [11] S. Allin Christe., Mr.M.Vignesh., Dr.A.Kandaswamy., 2011,"An Efficient FPGA Implementation Of MRI Image Filtering And Tumour Characterization Using Xilinx System Generator", International Journal of VLSI design & Communication Systems (VLSICS) Vol.2, No.4
 - [12] Rashmi Bisht., Ritu Vijay., 2017,"Hardware Implementation Of Real Time Window Based Switching Median Filter", International Journal Of Engineering Sciences & Research Technology, 6(7):DOI: 10.5281/zenodo.834473
 - [13] Chandrajit Pal., Avik Kotal., Asit Samanta., Amlan Chakrabarti., Ranjan Ghosh., "Design space exploration for image processing architectures on FPGA targets", University College of Science, Technology and Agriculture, University of Calcutta, 92, APC Road, Kolkata, India
 - [14] Ravi.s., Abdul Rahim.B., Fahimuddin shaik.,2013, "FPGA Based Design and Implementation of Image Edge Detection Using Xilinx System Generator", International Journal of Engineering Trends and Technology (IJETT) – Volume 4 Issue 10.
 - [15] Nazia Abdul Majeed., Satheesh Rao., 2015,"FPGA Based Design Implementation for Detection of Exudates Using XSG", International Journal of Innovative Research in Computer and Communication Engineering Vol. 3, Issue 4.
 - [16] Amruta L kabade., Dr.V.G. Sangam., 2016, "Canny edge detection algorithm", International Journal of Advanced Research in Electronics and

Communication Engineering (IJARECE) Volume 5, Issue 5.

- [17] S. Nandy., B. Datta., D. Datta., "Implementation Sobel Edge Detector on FPGA", International Journal of Computer Sciences and Engineering, Volume-6, Issue-2
- [18] Jayasree M., N K Narayanan., Kabeer V and Arun C R., 2018, "An Enhanced Block Based Edge Detection Technique Using Hysteresis Thresholding", Signal & Image Processing: An International Journal (SIPIJ) Vol.9, No.2.
- [19] Balaji V R; "A Comparison of Compression Sensing Algorithm and DUET algorithm for Advanced DCT based Speech Enhancement System for Vehicular noise", International Journal of Pure and Applied Mathematics, 2018, Volume 119 No. 12 2018, 1385- 1394.
- [20] Balaji V R.; Sathiya Priya.J.; "Enhancement of Speech Signal Using Modified Binary Mask Based Algorithm for Vehicular Noise", 2018, Journal of Advanced Research in Dynamical & Control Systems, Vol. 10, 12-Special Issue, 2018.
- [21] V. R. Balaji .; C. Thulasi.; "The Study on Revelation of Glaucoma using Structural Features", 2019, Indian Journal of Science and Technology, Vol 12(2), DOI: 10.17485/141364.
- [22] Balaji.V.R.; Thulasi.C.; "Detection Of Glaucoma In Fundus Image-A Survey", 2nd International Conference on Recent Advances in Engineering and Technology, 2019, 8th & 9th Feb.ISBN: 978-93-87862-50-0.
- [23] Balakrishnan, S., Janet, J., Sujatha, K., & Rani, S. (2018). An Efficient and Complete Automatic System for Detecting Lung Module. Indian Journal Of Science And Technology, 11(26). doi:10.17485/ijst/2018/v11i26/130559
- [24] Sujatha, K., Krishnan, S., Rani, S., & Bhuvana, M. (2018). Biometric Authentication System with Hand Vein Features using Morphological Processing. Indian Journal Of Science And Technology, 11(26). doi:10.17485/ijst/2018/v11i26/130558
- [25] P.Palanikumar, S.Geofrin Shirly, Balakrishnan S, "An Effective Two Way Classification of Breast Cancer Images", International Journal of Applied Engineering Research, ISSN 0973-4562, Volume 10, Number 21 (2015) pp 42472-42475.
- [26] D. Dharunya Santhosh, S. Balakrishnan, C.K.Dhivyasshri, N.Prakash, "Biometric Authentication System Using Matlab", International Journal of Engineering and Technology (UAE). Vol. 7, (4.19) (2018), pp. 101-103.
- [27] S. Balakrishnan, B. Persis Urbana Ivy and S. Sudhakar Ilango, "A Novel And Secured Intrusion Detection System For Wireless Sensor Networks Using Identity Based Online/Offline Signature", ARPN Journal of Engineering and Applied Sciences. November 2018, Vol. 13 No. 21, pp. 8544-8547.
- [28] S.Balakrishnan, Vinod K, B. Shaji. (2018). "Secured and Energy Efficient

- AODV Routing Protocol For Wireless Sensor Network”, International Journal of Pure and Applied Mathematics, Vol. 119, No. 10c, 2018, pp. 563-570.
- [29] S.Balakrishnan, J.P.Ananth, L.Ramanathan, S.P.Premnath, (2018). “An Adaptive Energy Efficient Data Gathering In Wireless Sensor Networks”, International Journal of Pure and Applied Mathematics, Volume 118 No. 21, 2018, pp. 2501-2510.
- [30] J.P.Ananth, S.Balakrishnan, S.P.Premnath, (2018). “Logo Based Pattern Matching Algorithm for Intrusion Detection System in Wireless Sensor Network”, International Journal of Pure and Applied Mathematics, Volume 119, No. 12, 2018, pp. 753-762.
- [31] Ranjeethapriya K, Susila N, Granty Regina Elwin, Balakrishnan S, “Raspberry Pi Based Intrusion Detection System”, International Journal of Pure and Applied Mathematics, Volume 119, No. 12, 2018, pp.1197-1205.
- [32] S.Balakrishnan, S.Sheeba Rani, K.C.Ramya, “Design and Development of IoT Based Smart Aquaculture System in a Cloud Environment”, International Journal of Oceans and Oceanography, ISSN 0973-2667, Volume 13, Number 1 (2019), pp. 121-127.
- [33] J.Janet, S.Balakrishnan, S.Sheeba Rani, “IOT Based Fishery Management System”, International Journal of Oceans and Oceanography, ISSN 0973-2667, Volume 13, Number 1 (2019), pp. 147-152.
- [34] J.Janet, S.Balakrishnan, S.Sheeba Rani, “IoT based lake and reservoir management system”, International Journal of Lakes and Rivers (IJLR), Vol. 12, Issue 1, (2019), pp. 21-25.
- [35] S.Sheeba Rani, S.Balakrishnan, V.Kamatchi Sundari, K.C.Ramya, IoT Based Water Level Monitoring System for Lake in a Cloud Environment, International Journal of Lakes and Rivers (IJLR).