IMAGE COMPRESSION USING JPEG AND LZO FOR LOW POWER LOSSLESS WIRELESS CAPSULE ENDOSCOPY

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Abstract

Recent advances in capsule endoscopy systems have introduced new methods and capabilities. The capsule endoscopy system, by observing the entire digestive tract, has significantly improved diagnosing gastrointestinal disorders and diseases. The system has challenges such as the need to enhance the quality of the transmitted images, low frame rates of transmission, and battery lifetime that need to be addressed. One of the important parts of a capsule endoscopy system is the image compression unit. Better compression of images increases the frame rate and hence improves the diagnosis process. In this paper a high precision compression algorithm with high compression ratio is proposed. In this algorithm we use the similarity between frames to compress the data more efficiently

I.INTRODUCTION

Wireless capsule Endoscopy is a state of art technology which receives images of human Intestine for medical purposes and diagnostics. Wireless Capsule endoscopy (WCE) is a procedure in which a tiny wireless camera is used to capture images of gastrointestinal tract these images are transmitted through wireless transmitter after compression. The camera embedded inside a vitamin-sized capsule that patient has to swallow. As the capsule travels through the digestive tract, the image sensor takes thousands of pictures with the help of led lights that are compressed and buffered then transmitted through transmitter unit of capsule to a recorder patient wear on a belt around the waist or over the shoulder (Figure-1) Complete Capsule Endoscopy System). Capsule endoscopy helps the physician evaluate the small intestine and digestive tract. The small intestine is very narrow thus it cannot be reached by conventional endoscopy techniques like upper endoscopy or colonoscopy.The wireless capsule endoscopy is basically and broadly used for searching reasons of internal bleeding in small intestine. It is also be useful for detecting polyps, diseases caused by inflammation in bowel, ulcers, and tumors of the small intestine.[2]

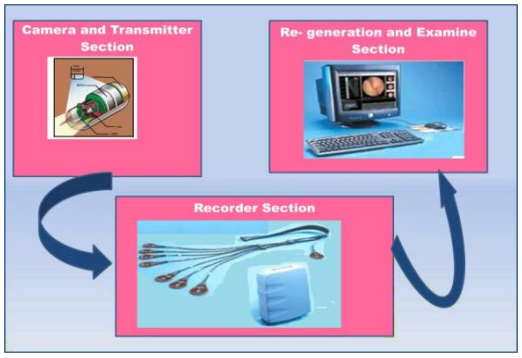

Figure 1. Wireless Capsule Endoscopy Systems

1.1 INTRODUCTION TO ENDOSCOPY

Endoscopy provides unprecedented diagnostic capabilities for certain ailments that no other method can match today, such as detecting polyps in the colon and ulcers or fungi in the GI tract. Diagnosis with endoscopes is radiation-free and can be done with minimal pain to the patient. With these inherent benefits, physicians have aggressively adopted endoscopic techniques and are continually demanding innovation to improve imaging capabilities even further. Such demands force suppliers to deploy new techniques such as Narrow Band Imaging, Auto fluorescence Imaging, and Multi-Band Imaging.[3]

These methods provide much more accurate visualization of blood vessels, lesions, and mucosal surfaces than could be achieved in earlier endoscope systems, enabling physicians to more accurately diagnose patient ailments. Endoscopy greatly improves the quality of patient care by enabling minimally invasive surgical techniques. While traditional surgeries required large incisions to enable surgeons to view the subject tissue and to use large, hand-held instruments, endoscopes and laparoscopes (a type of endoscope with a rigid tube) enable minimally invasive surgical techniques with only one or two incisions less than a centimeter in length. This greatly reduces risk of infection and provides faster patient recovery time, allowing patients to leave the hospital in days compared to weeks for many procedures. Shorter hospital stays are a big benefit to the cost structure of health care providers and insurance companies. However, laparoscopic procedures tend to be more expensive andtakelonger to perform than open cavity procedures. So the health care providers are continually pushing for innovative ways to perform operations more efficiently and at a lower cost point. Physicians want equipment to be small, flexible and light weight so they can easily position their equipment for sustained periods of time to maximize patient comfort without causing operator fatigue. Within the case of both diagnostic and surgical endoscopy, burden is placed on the physician to manoeuvre equipment through small openings to obtain a usable visual image of the subject.

In diagnostic procedures with flexible endoscopes, the physician often has to hold the endoscope for a period of time. In surgical procedures, although equipment is mounted on a mechanical assembly, several laparoscopes and operating tools are used simultaneously in a confined location, leading to complexity in setting up for a procedure.

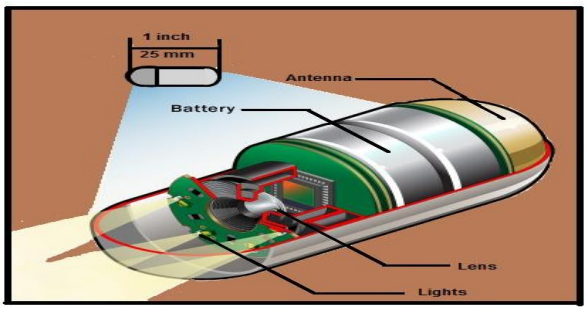

Figure 2 Endoscopic Capsules Internal Architecture

II. PROPOSED METHODOLOGY

2.1 RESEARCH METHODOLOGY ADOPTED

The main problem with the traditional wireless endoscopic capsule is techniques used for image compression, data transmission rate, size of capsule, battery life and reconstruction of images. Here a research methodology is adopted to reduce memory requirement as well as to increase compression rate and reduce size of compressed image upto 78 % which is very small and easily transmitted wirelessly with less battery use. Addition to this approach here battery life is also improved using FINFETs 16nm technology in manufacturing of capsule in place of traditional transistor. First part of research methodology is completely focused to image sensor and image compression section because if the sensor is having high quality and resolution it takes images with high quality and these high quality images are then applied to the compression block where two compression techniques are used to compress the image as fast as possible and it required very less memory. The lesser the memory size, better is the size of capsule and battery life. To compress image two compression techniques are used first is JPEG compression which compresses image up to 40% and this compressed image is further applied to LZO block for additional compression and the final output is tremendously reduced and takes very less battery for transmission.

2.1.1 CAMERA INTERFACE WITH I2C BUS

As shown in the Figure-3, the image sensor is connected to first compression block - JPEG block through I2C bus which is a two wire bi-directional interface. Image sensor ports connect to the development board with the KAC-1310 sensor to provide timing, control and to read the image data. JPEG Compression block ports connect the address, bidirectional data, and control signals on the board.

The master control signal generator component gives commands to I2C, a two wire bi-directional interface to control the image sensor outputs. A control module is created to simplify interface of KAC-1310 sensor with I2C bus and constrain it to the specific

application. The image sensor is having forty 8-bit control registers that can be read and written

to using a sequence of I2C events. A clock generator is used to provide sync pulses for the whole system .The image sensor is controlled by the master controller. The memory controller handles arbitration between different components that access the memory, interleaving read and write operations. The memory controller handles frame paging as well. Paging is used here so that any image cannot be read out before it is written or coming completely to image sensor.

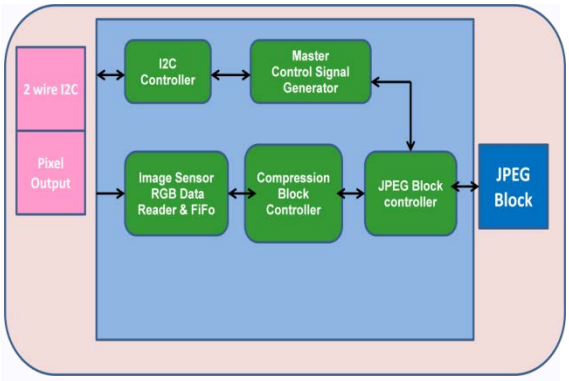

Figure 3 Image Sensor Interface through I2C bus

2.1.2 COMPRESSION BLOCK JPEG BLOCK

The output from image sensor is then provided to compression block which consists of two sub-blocks –one is JPEG and other is LZO block shown in Figure-.4the compressed image from JPEG block is then fed to LZO compression block and then they are transmitted through antenna to the receiver which is placed outside of patient body.

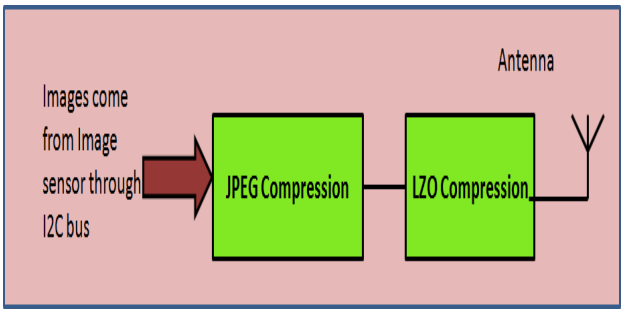

Figure 4 Block Diagram of Compress

But here we are using JPEG technology for image compression and the compressed images comes from JPEG block are applied to LZO compression block so that the memory requirement reduces. This compressed image is the applied to transceiver section where the compressed frames are transmitted .Due Compresses size, these images transmission takes less power and power consumption reduces up to 60-65%. At the receiver side received image is decompressed using LZO decompression and then JPEG decompression to extract original image.

2.1.3LZO COMPRESSION

LZO compression is basically used in real time applications. Compression is used to reduce the number of bytes to be transmitted, efficiently improves the network efficiency and performance as well as reduces the size of data very much. The main feature of this library is its portability, lossless data compression quality.LZO compression is basically a compression library which is written ANSI C language and this technique can be used in compression as well as fast decompression with any platform like windows, linux, ubunto, Android, IOS and even embedded systems also.LZO versions are also available for Perl, Python and java languages.(GNU) General Public License controls the distribution of LZO algorithms and its implementations. LZO decompression algorithm is simple and very faster than its contemporaries. LZO compression is basically used in real time applications like stoke market.LZO is a block compression technique and it runs its index for a big length of matched data. For compression and decompression block size of data must be the same.

It also accepts non-compressible data and expands incompressible data by maximum of a perfect ratio 1/64 of the original input data.

State Diagram of LZO Algorithm

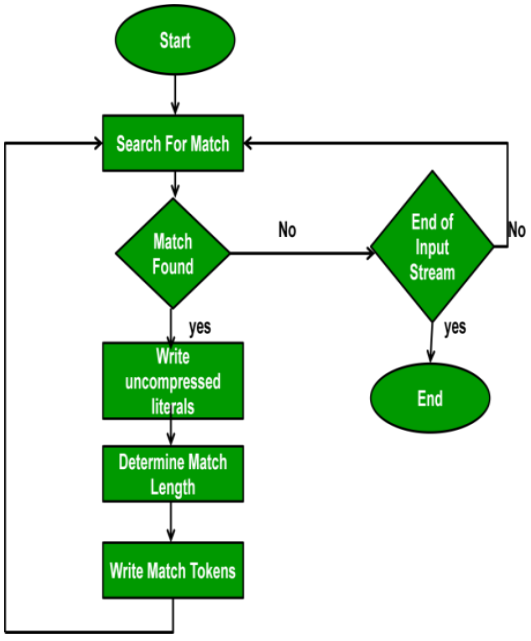

Figure 5 State Diagram of LZO Algorithm

III.SIMULATION RESULTS AND ANALYSIS

3.1 CORNER CLIPPINGTECHNIQUE

Using corner clipping technique, image compression can be done and results are checked on MATLAB. As corner clipping value is provided, image is compressed accordingly and compression ratio and bits per pixel values with images are shown in Figure-6.

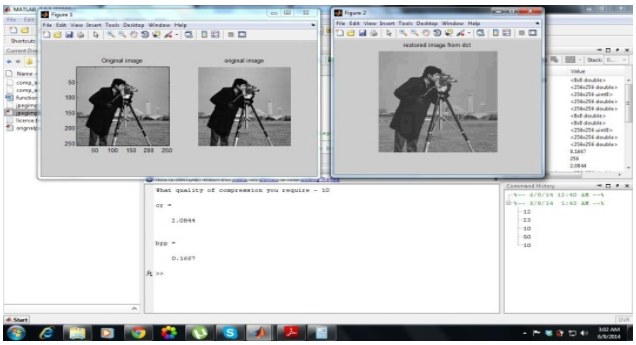

Figure 6 Compression Results based on Corner Clipping

It shows results of corner clipping algorithm. As value entered10, compression ratio 2.0844 is obtained after simulation.

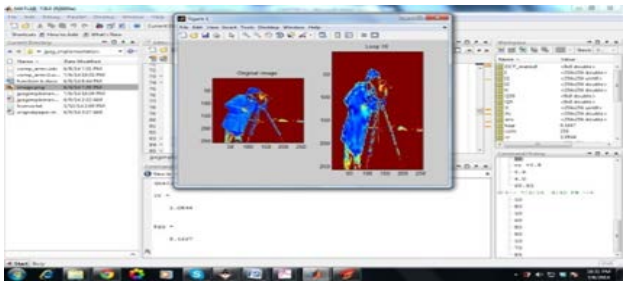

Figure 7 Compression and restoring image with corner clipping value 10

As corner clipping value is 10, image is restored which is shown in Figure -7 with compression ratio 2.0844 and bit per pixel 0.1667. If corner clipping value is very high, as shown in Figure-8, after compression image is distorted and restored image is not generated.

Result of high corner clipping value is shown in Figure-8, where after applying corner clipping value 85, image is compressed but when we try to restore it, image is distorted and could not be regenerated shown in Figure - 9. This is the disadvantage of corner clipping method. The compression ratio and bit per pixel value as same as previous but due to more clipping of corners, original image is not reconstructed shown in the below Figure - 9. The compression ratio and bit per pixel value as same as previous but due to more clipping of corners, original image is not reconstructed shown in the below Figure– 9.

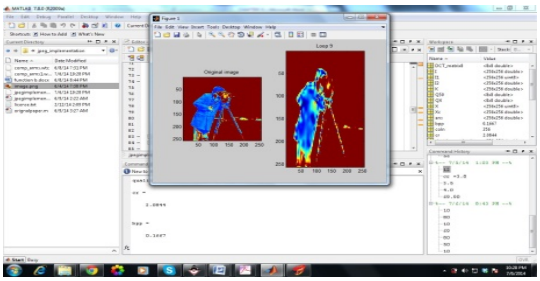

Figure 8 Corner Clipping Result with value 85

But restoring of image is not possible because it is highly distorted thus lesser the corner clipping, higher the quality of image and its restoring is possible.

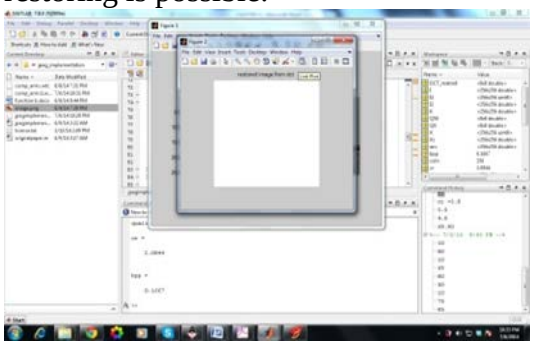

Figure 9In corner Clipping higher value restores no image

Higher the corner clipping value, compression is done but restoring of image at receiver side is not possible.

3.2 JPEG COMPRESSION

Here we are using JPEG compression technique which gives better compression ratio than the previous method. The results of JPEG compression are also shown here.

Image quality after compression is provided and compression is done using MATLAB and the restoring image is also possible.

Case-1:- Quality of compression is provided 10 and the result shown in Figure- 10. When require quality of compression is provided 10, results are better than corner clipping method. Compression ratio 11.1313 is achieved as well as quality of image is increases that are shown in Figure- 11. Restored image quality is better than restored in corner clipping method with same values.

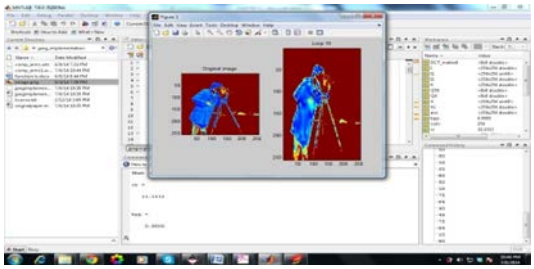

Figure 10 Case 1- Compression quality 10

Higher the quality of compression better is the result and restoring is also possible. The quality of compression is fed by operator and the results are analyzed and Figure- 10 and Figure-11 shows the results with compression quality fed to the software and reconstructed image is examined.

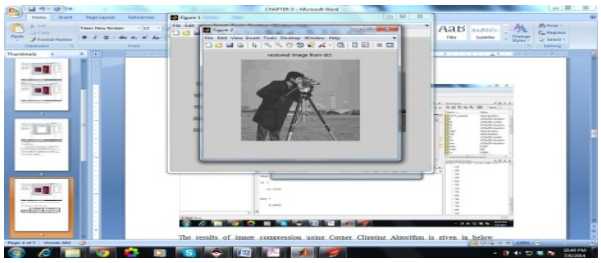

Figure 11with compression quality 10 restored image

Higher the quality of compression better is the result and restoring is also possible.

Case-2:-Quality ofcompression=90

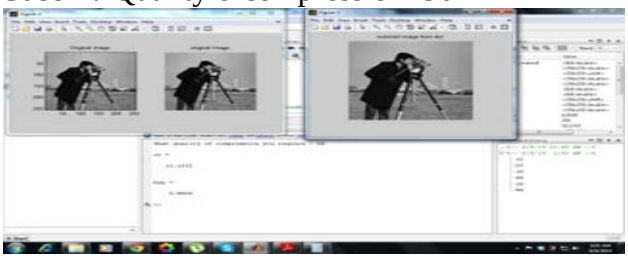

Figure 12 Case- 2 with Compression value 90

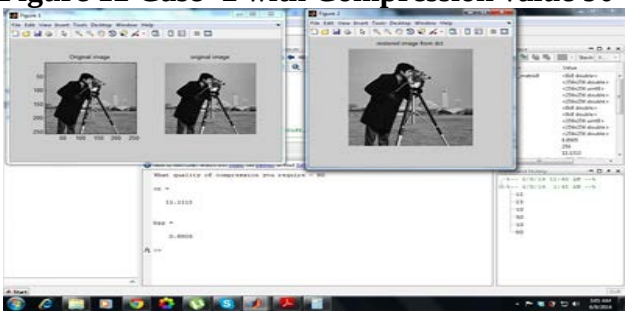

Figure 13 Results based on JPEG Compression

When quality of compression is 90, the resultant compression ratio and bit per pixel value from JPEG compression is obtained same as previous shown in Figure – 12 as well as quality of restored image is much better than the quality of image of 10 value shown in the above Figure - 13.

Table 1 Comparison Table Corner Clipping and JPEG Compression Ratio

Compression Techniques	Original image after Corner Clipping compression	Compression Using JPEG technique
Compression Ratio	2.0844	11.1313

When quality of compression is 90, the resultant compression ratio and bit per pixel value from JPEG compression is obtained same as previous shown in Figure 12 as well as quality of restored image is much better than the quality of image of 10 value shown in the above Figure - 13. according to the comparison results, JPEG is much better than Corner clipping method. Compression ratio which we get in Corner clip[pin is just 2.0844 and in case of JPEG compressionitis11.1313aswellasifcompressionquality increases,imageisrestoredin

JPEG compression but in case of Corner clipping, more corner clipping value distorted image and it cannot regenerated at the decoder end.

IV CONCLUSION AND FUTUREWORK

4.1CONCLUSION

In combining JPEG and LZO when compressing images using the JPEG standard, the following was achieved:

Corner Clipping provides on 73%compression

JPEG provides compression ratio 11:1 and thus it is 89 to 90% of an image

LZO provides compression ratio 15:1 this is the best ratio.

LZO is a basically a data compression library for real time applications which is suitable for data de-/compression. In real time applications speed is more concern than compression ratio.It also favours speed over compression ratio. LZO achieves quite competitive compression ratio using slower compression levels while decompression is extremely fast.The use of corner clipping gives results better and it was an obsolete technique because advancement in vlsi improves all areas connected to it directly or indirectly. Using 16nm FinFET provides much better results than 18 µ m micrometer technique.

4.2FUTURE WORK

This research shows many improvement methods in the traditional wireless capsule endoscopy image compression. Here CMOS camera sensor is used for high quality and high resolution. Using JPEG and LZO compression techniques it is possible to compress image up to 80 to 85 % and thus while transmission, more than 2 frames can be transmitted. As the traditional capsule only transmits 2 frames per second because of battery life and image size when image size is very less, battery is very less required and thus more than 2 frames can be

transmitted at the same or even less power consumption. Another improvement is while using 0.18 µm technology of Silicon the memory size is a concern as it also requires power. Using FinFET 16 nm technology in camera sensor manufacturing and in buffer memory the power requirement reduces because in FinFET less leakage current occurs. It can be operated at a very low operating voltage and thus battery life improves using FinFET technique. JPEG with combination of LZO requires very less memory and memory is manufactured using 16nm technology, so capsule battery life increases. This would be in the area of expanding on the digital material on which this technique can be applied to. This research can be a future expended to wireless capsule endoscopy because in the traditional capsule the memory requirement increases and thus Corner Clipping is used to reduce memory requirement. But using JPEG and LZO compression techniques,
firstlythe image size reduces very much and memory requirement is also reduces because to buffer compressed images less memory is required.

V. REFERENCES:

[1] shenghuaGao,Tsang“Learning Category-Specific Dictionary and Shared Dictionary for Fine Grained Image Categorization”, Image Processing, IEEE Transactions, Volume : 23, Issue : 2 , ISSN :1057-7149, P-P:623 – 634, Feb. 2014.

[2] Rezvanifar,AIsfahan,Iran,khoravifard “Including the Size of Regions in Image Segmentation by Region-Based Graph”, Image Processing, IEEE Transactions, Volume : 23, Issue: 2 , ISSN :1057-7149, P-P: 635 – 644, Feb. 2014.

[3] Bae ,S,Kim M.A “Novel Generalized DCT-Based JND Profile Based on an CM-JND A Model for Variable Block-Sized Transforms in Monochrome Image Processing, IEEE Transactions , ISSN :1057-7149 ,Volume : 23, Issue: 8 ,P-P:3227 – 3240 , 02 June 2014.

[4] Chen-kuochiang-Hsienliu“Learning Component-Level Sparse Representation for Image and Video Categorization”, Image Processing, IEEE Transactions, Volume: 22, Issue: 12,ISSN :1057-7149, P-P: 4775 – 4787 , Dec.2013.

[5] Qiegen Liu, Shanshanwang ,ying L, Xi peng , “Adaptive Dictionary Learning in for sparse Gradient domain image recovery” image processing IEEE transaction ,ISSN:1057-7149,Volume :22 issue 12 pp 4652 -4663, Dec2013

[6] X. Zhan, R. Zhang, D. Yin and C. Huo, "SAR Image Compression Using Multiscale Dictionary Learning and Sparse Representation," in IEEE Geoscience and Remote Sensing Letters, vol. 10, no. 5, pp. 1090-1094, Sept. 2013, doi: 10.1109/LGRS.2012.2230394.

[7] I. Ram, M. Elad and I. Cohen, "Image Processing Using Smooth Ordering of its Patches," in IEEE Transactions on Image Processing, vol. 22, no. 7, pp. 2764-2774, July 2013, doi: 10.1109/TIP.2013.2257813.

[8] W. Zhang, X. Hu, X. Li and N. Yu, "Recursive Histogram Modification: Establishing Equivalency Between Reversible Data Hiding and Lossless Data Compression," in IEEE Transactions on Image Processing, vol. 22, no. 7, pp. 2775-2785, July 2013, doi: 10.1109/TIP.2013.2257814.

[9] N. Fout and K. Ma, "An Adaptive Prediction-Based Approach to Lossless Compression of Floating-Point Volume Data," in IEEE Transactions on Visualization and Computer Graphics, vol. 18, no. 12, pp. 2295-2304, Dec. 2012, doi: 10.1109/TVCG.2012.194.

[10] Lien GS, Liu CW, Jiang JA, Chuang CL, Teng MT. Magnetic control system targeted for capsule endoscopic operations in the stomach--design, fabrication, and in vitro and ex vivo evaluations. IEEE Trans Biomed Eng. 2012;59(7):2068-2079. doi:10.1109/TBME.2012.2198061

[11] C. Fu, X. Ji and Q. Dai, "Adaptive Compressed Sensing Recovery Utilizing the Property of Signal's Autocorrelations," in IEEE Transactions on Image Processing, vol. 21, no. 5, pp. 2369-2378, May 2012, doi: 10.1109/TIP.2011.2177989.

[12] Bettahar ,S,stambouli,A.B Lambert ,P. “PDE-Based Enhancement of Color Images in RGB Space”, Image Processing, IEEE Transactions, ISSN: 1057- 7149,Volume:21 , Issue: 5,P-P: 2500 – 2512,May2012.

[13] Ciuti G. ,Salerno M. ,Lucarini G.,Valdastri P. , Arezzo A. , Menciassi A. , Morino,M., Dario P.,“A Comparative Evaluation of Control Interfaces for a Robotic-Aided Endoscopic Capsule Platform” ,Robotics, IEEE Transactions,ISSN:1552-3098, Volume:28 , Issue: 2, P-P: 534 – 538, April2012.

[14] C. Ponce and A. Singer, "Computing Steerable Principal Components of a Large Set of Images and Their Rotations," in IEEE Transactions on Image Processing, vol. 20, no. 11, pp. 3051-3062, Nov. 2011, doi: 10.1109/TIP.2011.2147323.

[15] T. H. Khan and K. A. Wahid, "Low Power and Low Complexity Compressor for Video Capsule Endoscopy," in IEEE Transactions on Circuits and Systems for Video Technology, vol. 21, no. 10, pp. 1534-1546, Oct. 2011, doi: 10.1109/TCSVT.2011.2163985.