

MONITORING OF SHRIMP STATUS USING MACHINE LEARNING

P. Chaitanya Varma
Research Scholar
Dept. of C&I. Kalasalingam
University
Krishnankoil, Srivilliputtur.
Pinnamaraju13@gmail.com

R.P Surya Shankar
Associate Professor
Dept. of C&I. Kalasalingam
University
Krishnankoil, Srivilliputtur.
rpssr20jan76@gmail.com

Dr. B. Kannapiran
Associate Professor
Dept. of C&I. Kalasalingam
University
Krishnankoil, Srivilliputtur.
Kannapiran@gmail.com

Abstract—Aquaculture, cultivation of organic creatures for instance like fish, prawn. Frequent change in climatic conditions has a direct impact on prawns underwater. The rancher may not have complete knowledge of prawns under water. Because prawn body does not float when it dies. So in this paper, we are designing a system for monitoring of shrimp status. With this system, we can observe the live status of prawns underwater. Raspberry Pi is used to capture images/videos of underwater images and at the same time, it serves as a server. Due to poor properties of light, the image captured underwater will not be quality. So we introduced an algorithm for image enhancement in the server, for improving the quality of the image. Farmer mobile will be connected to the server with provided authentication, where he can view all the enhanced images and can get benefited.

Keywords—Shrimp monitoring system, Machine vision, Raspberry Pi, Image Enhancement.

I. INTRODUCTION

Aquaculture, 'Aqua (water) culture (to grow)' is nowadays considered as a fast-growing industry because of significant increases in demand for seafood throughout the world. Aquaculture has appeared to be an appealing alternative for the enhancement of fish and shrimp production in the country. The growth of aquaculture sector during from 1980 to present period have increased over 1000% i.e. from 0.37 to 10.2 million tons.

Till date, there is no full automation process used in aquaculture for high yielding production. While comparing the investments for fish and prawn, the investment in prawns is too high with a short cultivation period of 3.5 months. Most careful precautions must take within that time. The pond water parameters will have a direct impact on the aquatic animals. Change in climatic conditions forces pond parameters to adapt to uneven rates. Pond parameters such as hardness, acidity, alkalinity, dissolved oxygen level play a significant role in aquaculture. The Farmer can check the water parameters, but he does not have any knowledge about the prawns in water. So to solve this, we are using an underwater camera mounted on a raspberry pi. Raspberry Pi is a mini, affordable, credit card size computer. The Rasbian operating system utilized in this, by which images and photos are taken and send to the local personal server where the image processing analysis is done and can view through LCD monitor Mounted on it.

II. RELATED WORK

Srividhya at el. 2015 Discussed the fundamental problems in underwater imaging. Problems related to Aquatic Environment, uneven illumination and floating particles. Authors equated all the existing approaches. Homomorphic, bi-lateral and anisotropic filters are taken and associated for the correction of non-uniform illumination. For the improvement of contrast, CLAHE is made on filtered images. For the removal of further noise and smoothing, comparison of Haar and Symlet wavelet de-noising is done. For the image enhancement, comparison of the histogram is done before and after the enhancement. For the evaluation of enhanced images, Quantitative metrics like PSNR, CNR, IEM, AMBE are related and estimated.

Ahmad at el. 2014 Discussed the poor image quality due to impurities and water properties like travel of light in a water medium, low contrast, blur, in-homogeneous lighting and colour. Authors proposed a method for image enhancement. In the initial phase, contrast improvement method is smeared to the image, next the image is applied to improved Von Kries assumption and straightening the image into two dissimilar images with the same intensity at the normal value w.r.t Rayleigh distribution. In the subsequent phase, colour conversion method is used where RGB values are converted into HSV values. This adjustment makes the colour components to increase their colour performance.

Varinderjit Kaur at el. 2014 Discussed the several techniques available for image enhancement. These methods are developed for any numbers of applications, regarding underwater, illumination and floating particles. Authors gave a detailed explanation of Non-linear image techniques for enhancement like Histogram equalization, adaptive histogram equalisation, Contrast limited AHE, dark channel, dominant brightness levels. Authors also discussed various algorithms proposed by different authors in image processing underwater domain.

Muhammad Suzuri Hitam et al. 2013 Discussed that insignificant luminosity of submerged images is triggered by water properties, here is a need to recapture the excellence of a marine image. Authors introduced Contrast Limited AHE colour model that exclusively established for marine image

enhancement. This technique functions CLAHE on RGB and HSV/HSI colour models and the results are joined together by means of Euclidean norm. Authors took the images from Island in Malaysia. Authors discovered that proposed method enriched the visual quality of marine images by reducing noise and enhancing contrast

III. COMPONENTS DESCRIPTION

1. Raspberry Pi: -

The Raspberry Pi is an advanced mini-computer, which is having the size of the smartphone, that plugs into a TV having HDMI port, and uses a standard keyboard and mouse.

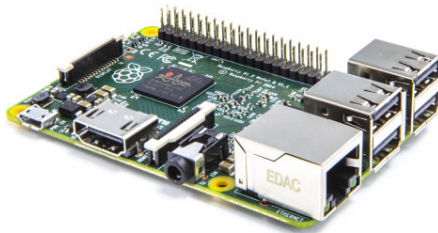


Figure 1: Raspberry Pi v3

The various functional components of raspberry pi are:

- SD card slot: Used to Install the operating system that supports the raspberry pi, here we are using Raspbian. Different type of OS's that support for raspberry pi is Arch Linux, open ELEC, Pidora, rasp BMC, Raspbian, RISC OS, open ELEC & XBMC, retro pie, Firefox OS, plan9.
- Cam module: The Raspberry Pi camera module is fit for taking full HD 1080p photo and video which can control programmatically.
- GPIO: Used to interact with the real world.
- Micro USB power port: + 5.1v.
- HDMI out: Can plug directly into a monitor or TV.
- Broadcom BCM 2837 64-bit: This is a system on chip with a 1.2GHz processor and 1GB ram.
- Ethernet: Used to connect raspberry pi to the internet and used for updating software.

2. Underwater Camera: -

The Pi camera module is capable of recording high-definition video and photos. Beginners can use this easily, but its depth makes experts expand their knowledge. Features like time-lapse, slow-motion and other camera editing tricks made very easy with a little prior knowledge. Supports 1080p, 720p, and VGA90 video modes.

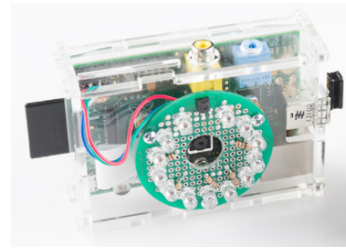


Figure 2: Raspberry Pi Camera with LED

The Pi camera module is peripheral with which we can use for different of practical and creative applications. With just a basic working knowledge of bash and python scripts, we can get the most out of cameras functionality. We can opt for a graphical application like RPI Camera GUI, and with the help of an SSH connection we can access and control the Raspberry Pi with the camera module remotely. The RPI Cam interface software makes the task easy for the job. RPI Cam software is a user-friendly interface and has an ability to control all our cameras through a browser. In Addition to that RPI, camera interface provides time-lapse, slow-motion, RGB changes, Scheduled shooting, motion trigger image Capture and much more. The underwater camera must support excellent image quality, compact, lightweight.

3. LCD display: -

Here we use an LCD display connected to Raspberry Pi to view all the images that are stored on the server. The captured image is stored in the server database. Which can monitor in LCD display that is connected to the raspberry pi. There is an option for the user to access the images on his own mobile, by connecting to a Local area network.

Specifications:

- Screen Dimensions: 194mm x 110mm x 20mm
- Screen size: 155mm x 86mm
- Resolution: 800 x 480 pixels

Using DSI port we can connect to Raspberry Pi using ribbon cable

IV. HARDWARE ARCHITECTURE

In the fig.3 Underwater camera is connected to Raspberry Pi through the USB port. Raspbian OS is installed in the SD-card of the Raspberry Pi. Here we use a minimum of 32GB SD card with class 10. But we recommend more memory capacity so that, there is a provision for our raspberry pi to act a server and at the same time storing videos and images that were captured by USB Underwater camera. Raspberry Pi is associated with Wi-Fi-router. Which helps to manage the server from other devices connected to a same Local area network. Python code has been written in such a way that when a motion is detected underwater, raspberry pi camera will be activated and takes the photo

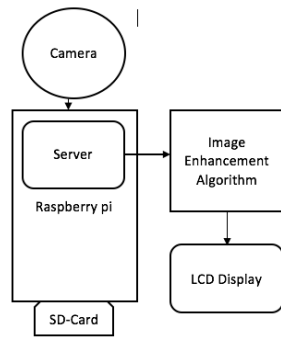


Figure 3: System Design

But due to the density of the water, the result will be a poor quality image. Image enhancement algorithm is proposed for the illumination and de-noising. The processed image is displayed on the LED display mounted on it.

V. WEB SERVERS SELECTION AND INSTALLATION

Raspberry Pi supports many web servers, of which Apache, Nginx, and Lighttpd are the best choice, because of their ease and library tools to be used on a Raspberry Pi. It is best to opt one and stick with that for the rest, Re-installing another server and leading to a confusion of multiple servers struggle for a port usage. For our easy and convenience, we use Apache web server. Apache can handle HTML files over HTTP and serve dynamic web pages with script languages such as PHP with an additional module. but before that, we have to update our Raspbian OS by using the command

```
Sudo apt-get update
Sudo apt-get dist-upgrade -y
Sudo RPI-update
```

Code for the installation of Apache:

```
Sudo apt-get install apache2 -y
```

There will be default HTML file in the internet browser which can be accessed by `http://localhost/` on PI itself, or just by opening `https://Pi'sIPaddress`. If the Apache two Debian default page opened, then it means apache is working. PHP is an open-source widely used general-purpose script language that is especially suited for web development and can embed into HTML. By using the below command we can install PHP on our Raspberry Pi.

```
Sudo apt-get install php5 libapache2-mod-php5 -y
```

There is a need for testing the installed PHP. Just create a file named, `Index.php`:

```
Sudo leafpad index.php
```

Now adding some message in the created file,
`<?php echo "Hello, PHP is working fine"; ?>` and save the file.
 Now go back and delete `index.html` file by using

```
Sudo rm index.html
```

Just refreshing browser, we can see "Hello, PHP is working fine." if this does not appear then restart apache server with the following code

```
Sudo service apache2 restart
```

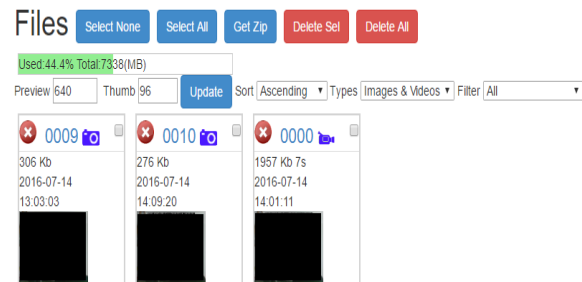


Figure 4: Raspberry Pi server interface

Server interface shows all the images and Videos that are saved in the server database. The images/Videos will be provided with the date, time that they are captured and also size. Memory space left over is also shown. These data can be downloaded in any device, which is connected to the LAN of the server.

VI. QUALITY & COMPRESSION OF IMAGES:

As we are using RPI MJPEG (for live streaming), there is a possibility for adjusting the quality and compression of the image. Quality of the image is Governed by the range [1 100] value of an image. The image may be live or captured. The quality 'Q' is not a match for normal JPEG Q factor because Q factor in Raspberry pi compression software is non-linear. For example, Consider the default value as 10, which is approximately 75 in JPEG usage and it results in a good picture with quality and file size specs.

Live Video Stream on Any Smartphone:

Go to the app store or play store and download "IP CAM VIEW PRO". Hit menu and select manage camera. Where we can add a camera and select raspberry pi camera interface. Enter your name and enter raspberry pi IP address. Test the saved file and press save and exit.

VII. PROBLEMS IN UNDERWATER IMAGING:

We need to consider some factors when we are dealing with underwater imaging. Affecting to underwater images, due to absorption of light and also the fundamental structure of the sea. Effects of color in underwater imaging must be taken into account. The familiar problem regarding the underwater image is the density of water when compared to air, water is 800 denser. When the light is incident on the water for air, it reflects and at the same time, it slightly penetrates. But due to higher density of water and the water molecule absorption, the amount of light starts decreasing as it goes deeper into the water. So the underwater images get darker as we go into the depth in the ocean. At the same time, the colour also drops off gradually according to the wavelength as the depth increases. At first, Red colour starts disappearing at 3m depth, next start orange colour and vanishes totally at 5m depth. Now yellow starts disappearing and completely vanishes at the depth of 10m. green and purple are the next to start disappearing at the advance depths. Because of its shortest wavelength, blue colour has the ability to travels to far distance into the water. This reason makes most of the images that are taken underwater appear to be blue in colour. As a fact, the excessive amount of blue colour is seen in all underwater images is due to its shorter wavelength.

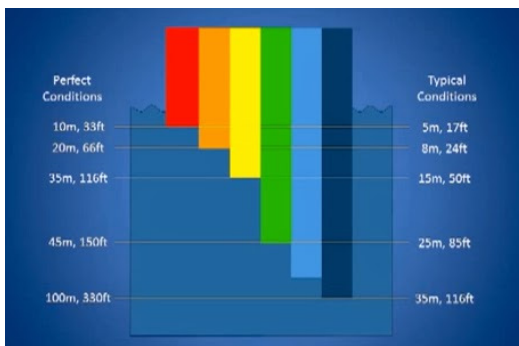


Figure 5: Light appearance Underwater

As we go deeper the brightness decrease and at the same time quality of the image also decrease. So because of this prawn images that taken underwater will not be visualized properly by a human.

VIII. THE PROPOSED APPROACH FOR IMAGE ENHANCEMENT:

The problem of image quality has to be taken into account while dealing with underwater images. The most efficient way to increase the quality of the image is to use image processing analysis. RGB colour space or HSV colour space can be used to process the colour vision. RGB describes its colour space in terms of a combination of primary colours like Red, Green and Blue. HSV describes its colour space in terms of more familiar comparison such as colour, vibrancy and brightness like Hue, Saturation, and Value. Color histogram equalization can be accomplished by transforming a colour image into HSV/HSI

image. In this HSV/HSI enhancement of the image will be done and at the same time, hue and saturation values are preserved. Firstly, we use RGB to HSV conversion. Hue is used to representing the colour type. However, hue circle contains 360 degrees of rotation, hue values are normalized to a range of 1 to 255, with 0 as Red. The vibrancy of the colour is represented by Saturation. It ranges from 0 to 255. If the saturation value increases, greyer is existing in the image. And makes the image faded. The brightness of the colour is used to represent by Value, with 0 to 255, where 0 is completely dark and 255 is fully bright. Each RGB component has a range of 0 to 255. Image representation to be changed to 0 to 1, which is possible by dividing with 255.

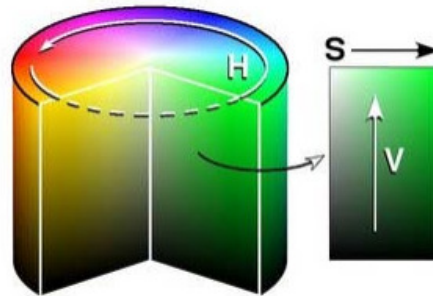


Figure 6: HSV/HSI image representation

$$\theta = \cos^{-1} \left\{ \frac{\frac{1}{2}[(R-G)+(R-B)]}{[(R-G)^2+(R-B)(G-B)]^{\frac{1}{2}}} \right\}$$

Now we have to find the value of Theta,

If $B \leq G$, then $H = \theta$

If $B > G$, then $H = 360 - \theta$

Dividing the Hue component by 360, so that we can represent in [0 1] range.

$$Hue(H) = \begin{cases} \theta, & \text{if } B \leq G \\ 360 - \theta, & \text{if } B > G \end{cases}$$

$$Saturation(S) = 1 - \frac{3}{(R + G + B)} [\min(R, G, B)]$$

$$Intensity(I) = \frac{1}{3} (R + G + B)$$

Secondly, we applied CLAHE - contrast limited AHE. The only difference with ordinary AHE is limiting in its contrast. Contrast preventive technique is for each vicinity. Where we derive a transfer function. The main reason behind using the CLAHE is to reduce over-amplification of noise. Neighborhood contrast amplification pixel value is set to the transfer function slope. Which is propositional to the slope of Vicinity Cumulative distribution function. CLAHE restricts the amplification by trimming the histogram at a predefined value before the computation of Cumulative distribution

function. This confines the slope of CDF. Histogram clipping value is called clip-limit, this also depends on the normalization of the histogram and size of the vicinity region. At last, we apply HSV/HIS to RGB changeover.

When $0 \leq \text{Hue} < 360^\circ$, $0 \leq \text{Saturation} \leq 1$, and $0 \leq \text{Value} \leq 1$.

$$\begin{aligned} \text{Color} &= \text{Value} * \text{Saturation} \\ X &= \text{Color} * (1 - |(\frac{\text{Hue}}{60^\circ}) \bmod 2 - 1|) \\ m &= \text{Value} - \text{Color} \\ (R', G', B') &= \begin{cases} (C, X, 0), & 0^\circ \leq H < 60^\circ \\ (X, C, 0), & 60^\circ \leq H < 120^\circ \\ (0, C, X), & 120^\circ \leq H < 180^\circ \\ (0, X, C), & 180^\circ \leq H < 240^\circ \\ (X, 0, C), & 240^\circ \leq H < 300^\circ \\ (C, 0, X), & 300^\circ \leq H < 360^\circ \end{cases} \\ (R, G, B) &= \begin{cases} (R' + m) * 255, \\ (G' + m) * 255, \\ (B' + m) * 255 \end{cases} \end{aligned}$$

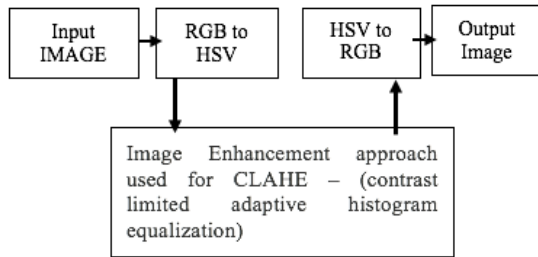


Figure 7: Proposed Methodology for Image Enhancement

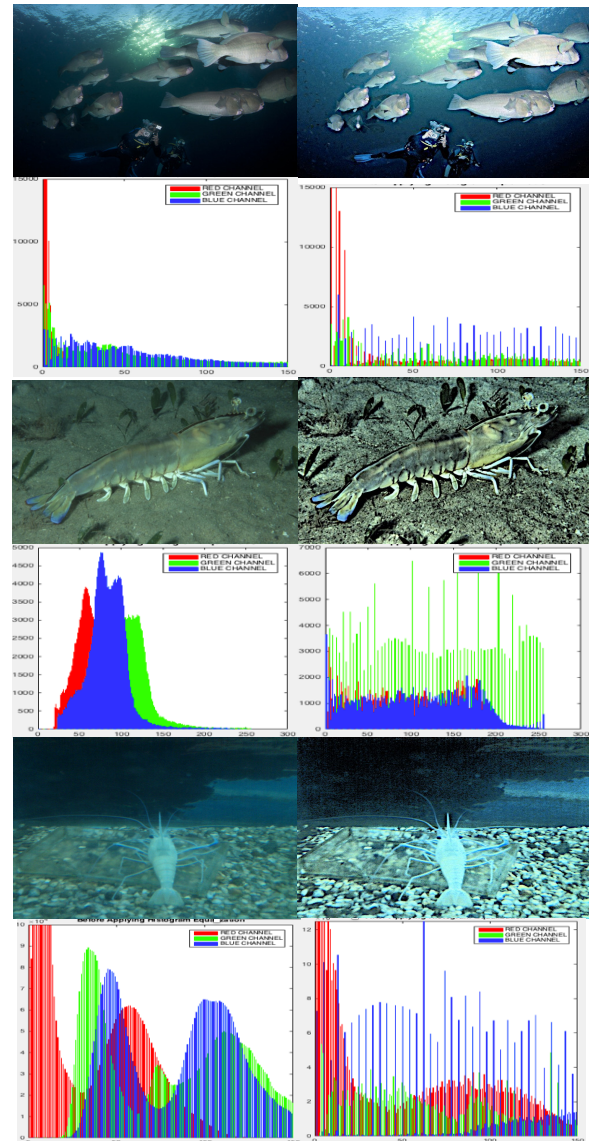
IX. RESULT AND DISCUSSION

All the data (Images and Videos) will be stored on the server, which is developed on the raspberry pi. Due to the higher density of water, low light and small particles, underwater images will not be cleared. The images enhancement algorithm used will enhance images and reduce the noise, provided with better results. In fig8. The comparison of original and enhanced images with the histogram is shown below.

X. CONCLUSION:

Thus we designed and industrialized a system that can record/capture underwater images/videos. Data storage will be done on the server, which is inbuilt in raspberry pi itself. Authentication is provided so that only concern person will have the power to access the server. The server can be accessed by raspberry pi or by any device that is connected to same local area network which raspberry pi is connected. In the server, we are implementing image enhancement algorithm for better results. User mobile can be connected to

the local area network to view the images and videos of the prawn underwater, which helps to take necessary action when required. As the crop cycle of the prawn cultivation is very small, with this aqua monitoring system, the user will get benefited and results in high yields profits



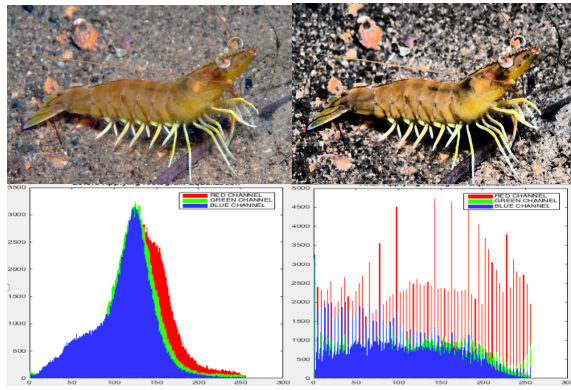


Figure 8: Original Image Vs Enhanced Image with their respective Contrast Adaptive Limited Histogram Equalization

XI. FUTURE WORK:

Video stream analysis of shrimp monitoring will be performed as-well-as based on the videos, movement of prawns will be detected using motion detection algorithm.

REFERENCE:

- [1] S. Bazeille, I. Quidu, L. Jaulin, and J. P. Malkasse, "Automatic underwater image pre-processing," in Proceedings of the Carcterisation du Milieu Marin (CMM '06), 2006.
- [2] M. Chambah, D. Semani, A. Renouf, P. Courtellemont, and A. Rizzi, "Underwater colour constancy: enhancement of automatic live fish recognition," in Color Imaging IX: Processing, Hardcopy, and Applications, vol. 5293 of Proceedings of SPIE, pp. 157–168, San Jose, Calif, USA, January 2004.
- [3] K. Iqbal, R. Abdul Salam, A. Osman, and A. Zawawi Talib, "Underwater image enhancement using an integrated colour model," International Journal of Computer Science, vol. 34, p. 2, 2007.
- [4] W. Hou, D. J. Gray, A. D. Weidemann, G. R. Fournier, and J. L. Forand, "Automated underwater image restoration and retrieval of related optical properties," in Proceedings of the IEEE International Geoscience and Remote Sensing Symposium (IGARSS '07), pp. 1889–1892, 2007.
- [5] W. Hou, A. D. Weidemann, D. J. Gray, and G. R. Fournier, "Imagery-derived modulation transfer function and its applications for underwater imaging," in Applications of Digital Image Processing, vol. 6696 of Proceedings of SPIE, San Diego, Calif, USA, August 2007.
- [6] T. Treibitz and Y. Y. Schechner, "Active polarization de-scattering," IEEE Transactions on Pattern Analysis and Machine Intelligence, vol. 31, no. 3, pp. 385–399, 2009.
- [7] Raimondo and Silvia, "Underwater Image Processing: State of the Art of Restoration and Image Enhancement Methods" in EURASIP Journal in Advance in Signal Processing, Vol 2010.
- [8] R. Rani, A. Verma, S. K. Verma, and U. Bansal, A hybrid approach of stretching and filtering for enhancing theunderwater grayscale image, International Journal in Foundations of Computer Science & Technology, vol.4, no.5, pp.25-34, 2014.
- [9] M. S. Hitam, W.N. J. H. W. Yussof, E. A. Awalludin, and Z. Bachok, Mixture Contrast Limited Adaptive Histogram Equalization for Underwater Image Enhancement, 2013 International Conference on Computer Applications Technology (ICCAT), pp.1-5, Jan. 2013.
- [10] H. Lu, Y. Li, S. Serikawa, Underwater Image Enhancement Using Guided Trigonometric Bilateral Filter and Fast Automatic Color Correction, 20th IEEE International Conference on Image Processing (ICIP), pp.3412-3416, Sep. 2013
- [11] W. N. J. H. W. Yussof, M. S. Hitam, E. A. Awalludin, and Z. Bachok, Performing Contrast Limited Adaptive Histogram Equalization Technique on Combined Color Models for Underwater Image Enhancement, International Journal of Interactive Digital Media, vol. 1, no. 1, pp.1-6, 2013.
- [12] R. Beohar, P. Sahu, Performance Analysis of Underwater Image Enhancement with CLAHE 2D Median Filtering Technique On the Basis of SNR, RMS Error, Mean Brightness, International Journal of Engineering and Innovative Technology, vol. 3, no. 2, pp.525-528, Aug. 2013
- [13] C. Srisailam, P. Sharma, and S. Suhane, Color Image Denoising Using Wavelet soft Thresholding, International Journal of Emerging Technology and Advanced Engineering, vol.4, no.7, pp.475-478, 2014.
- [14] K. S. Sidhu, B. S. Khaira, and I. S. Virk, Medical image denoising in the wavelet domain using haar and db3 filtering, International Refereed Journal of Engineering and Science, vol. 1, no. 1, pp. 001-008, 2012.
- [15] J. Kaur, R. Kaur, Biomedical Images denoising using Symlet Wavelet with Wiener filter, vol. 3, no. 3, pp. 548-550, 2013.
- [16] bt. Shamsuddin, N.; bt. Wan Ahmad, W.F.; Baharudin, B.B.; Kushairi, M.; Rajuddin, M.; bt. Mohd, F., "Significance level of image enhancement techniques for underwater images,"Computer& Information Science (ICCIS), 2012 International Conference on, vol.1, no., pp.490,494, 12-14 June 2012.
- [17] Pooja Sahu, Neelesh Gupta and Neethu Sharma," A Survey on underwater image enhancement techniques", InternationalJournal of computer allocation 87(13):19-23, Feb 2014.
- [18] Alka Tripathi, Ms.Pragya Gupta, Dr.Vineeth Richaria,"Haze Removal and Color Compensation of Underwater Image and

Dehazing", IJCSIT, vol.5 (3), ISSN: 0975-9646, March2014.

- [19] RP SuryaSankar, Chaitanya Varma," Design and Development of Aqua monitoring system using Machine Vision". IJCTA, 10(02), 2017, pp. 111-118.

ABOUT AUTHORS



Chaitanya Varma is pursuing Masters of technology in Department of Control and Instrumentation, Kalasalingam University, Srivilliputtur. He pursued his bachelor degree in Electronics and Instrumentation Engineering from VRSEC, Vijayawada, affiliated to JNTU Kakinada University. His Area of interests is robotics, industrial instrumentation and artificial intelligence.



R.P. Surya Shankar is an assistant professor in Department of Control and Instrumentation, Kalasalingam University, Srivilliputtur. He started his career in teaching from the year 1998. He guided more than 25 projects in instrumentation field. His area of interest is robotics, soft computing, machine learning, artificial intelligence.

B. Kannapiran was born in 1980. He obtained his Bachelor degree in Instrumentation and Control Engineering from Madurai Kama raj University, India in 2001 and Master degree in Applied Electronics from Madurai Kama raj University, India in 2002. He also obtained his PhD degree from Anna University Chennai, India in 2013. Presently he is working as Associate Professor in the Department of Instrumentation and Control Engineering, Kalasalingam University. He has published papers in International journals, National and International Conferences. His research topics include soft computing, Fault Diagnosis.

