IJCSE International Journal of Computer Sciences and Engineering Open Access
Review Paper Vol.-6, Issue-7, July 2018 E-ISSN: 2347-2693

A Literature Review On Satellite Image Data Enhancement Using Digital Image Processing

Kshipra Singh[1*], Jijo S Nair[2]

[1]Dept. Of Computer Science, Oriental Institute of Science and Technology, Bhopal, India
[2]Dept. Of Computer Science, Oriental Institute of Science and Technology, Bhopal, India

*Corresponding Author: kshipra.parihar@yahoo.in

Available online at: www.ijcseonline.org

Accepted: 06/Jul/2018, Published: 31/Jul/2018

Abstract— Image enhancement is one of the characteristic of image processing which is used for different real time application such as medical, scientific, geographical and military etc. In this paper, we mainly focus on the literature study of satellite image data enhancement. The major issues of satellite images are enhancement of gray-scale/colour image, noise, weak colour information, artifacts, distortion, large size, resolution high frequency content etc. To obtain the improved quality of satellite image various image processing techniques has been developed such as DWT, SVD, DT-CWT etc. and different authors also proposed some mechanism or algorithm of the image enhancement. This paper also presents the overview of various image enhancement techniques.

Keywords— DWT, SVD, Geographical, Image Enhancement, Satlleite data**.**

I. INTRODUCTION

The principle objective of image enhancement is to process an image so that the result is more suitable than the original image for a specific given application. Image enhancement is one of the most interesting and visibly appealing operations of image processing. Image enhancement divided into two widespread categories one is spatial domain method and another one is frequency domain method. The term spatial domain refers to the image plane itself, which directly deal with the image matrix and in frequency domain processing is done by modifying the Fourier transform of an image. Enhancement techniques based on various combinations of methods from these two categories are not unusual. When an image is processed for visual perception, the viewer is the ultimate judge of how accurate a particular method works, but here along with visual basis paper also check the results on qualitative scale measurement. Image processing is used in many applications like Remote Sensing, Medical Application etc. There are many types of images like panchromatic (PAN), multispectral (MS), hyper spectral (HS), synthetic aperture radar (SAR) etc. Covering different parts of electromagnetic spectrum are capture by different earth observation satellites. The Satellite images have issues with their resolution, so the images which loses their high frequency contents. And they appeared as blurred image. Also many issues are related with the satellite images. Therefore the enhancement of the image is necessary to improve the visibility of the image to remove unwanted noise, artifacts, to improve contrast and to find more details. So that the some useful information is extracted to get enhance image. This is important reason behind image enhancement methods. [1-2]

The rest part of the paper is organized as follows: Section II describes about the literature of the image enhancement proposed by the researcher. Section III explained about the image enhancement techniques and last section presents conclusion of the paper.

II. LITERATURE SURVEY

To improve the quality or perception of the image different researchers proposed or implemented various approaches. In this section literature of the related work about the enhancement of the satellite digital images is discussed.

Bongulwar [3] proposed a satellite image contrast enhancement technique based on the discrete wavelet transform (DWT) and singular value decomposition (SVD).In this technique DWT decomposes the input low contrast satellite image into four frequency sub bands referred to as low-low (LL), high-low (HL). Low-high (LH), high-high (HH) and estimates the singular value matrix of the low-low sub band image. The singular value matrix represents the intensity information of the given image and any change on the singular values change the intensity of the input image. After reconstructing the final image by using inverse dwt, the resultant image will not only be enhanced with respect to illumination but also will be sharper with good contrast. This technique is compared with conventional image equalization technique such as general histogram equalization (GHE). The visual and quantitative results suggest that the proposed DWT and SVD method clearly out performs the GHE method. Sahnoun [6] presented a new coding scheme for satellite images. At first, the image will be downloaded followed by a fast Fourier transform FFT. The result obtained after FFT processing undergoes a scalar quantization (SQ). The results obtained after the quantization phase are encoded using entropy encoding. This approach has been tested on satellite image and Lena picture. After decompression, the images were reconstructed faithfully and memory space required for storage has been reduced by more than 80%. Xue Mei et al. [7] proposed a novel method of image enhancement with respect to the fractional Fourier transform is presented. This method filters image in the fractional Fourier domain instead of the Fourier domain which is usually applied to the classical image enhancement. The fractional Fourier transform has a rotation angle a, characters of image thus change in different transform domain. In a proper fractional Fourier domain with angle a, ideal low-pass filter makes image smoother and ideal high-pass filter loses less information of image than in the traditional Fourier domain, which provides an alternative way to enhance image with proper filter designing. P. Suganya, N. Mohanapriya et. al. [1] in this work author proposed method for satellite image enhancement which includes Haar filter for pre-processing, Multi Wavelet Transform, Interpolation Process, Inverse Process of Multi Wavelet Transform for the low resolution image. The Multi Wavelet Transform and Interpolation technique used to produce fewer artifacts. Limitation of this method is not effective method to reduce distortion and for losing of high frequency content. Also in this work describes about Inter-Sub band Correlation Technique using Sub Bands- It used when an image is in low resolution, the image will be not clear that it is denoted as blur image. So that the frequency will also be very low and discontinuous, property is shift variant because of frequency is not continuous, the property keeps on changing. If the resolution is high, the image will be clear because of the frequency will be as much as continuous. Using Inter-Sub band correlation is we can get continuous frequency therefore the shifting property keeps invariant. Advantage of it the low resolution image will get clear and enhanced. Bhateja, V. et al. [8] proposed a truncated Volterra filter combination to provide contrast enhancement as well as texture based processing of masses in digital mammograms. Noteworthy improvement in visualization of masses has been observed in the simulation results carried out on cases from DDSM database. The improved performance of the proposed filtering approach is well supported with calculated values of objective evaluation parameters. Zouari, M. et al. [9] proposed a new approach for enhancing micro-calcifications in digitized mammogram digitized mammogram, emphasizing corresponding gray level details. Accordingly, they proposed an adaptive exponential function which creates a local modification of gray level to highlight details which are potential carriers of micro-calcifications. They have applied the NLS twice: locally and globally. The performance of micro-calcification's enhancement method is developing using Farabi Digital Database of Screening Mammography (FDDSM). Performance results are given in terms of the Second-Derivative-like Measure of enhancement (SDME). Our proposed approach achieves 118 of the local NLS and 115 of the Global NLS. Wenkao Yang, Jing Wang et. al. [4] author proposed method based on principal components analysis (PCA) is a statistical technique that can convert multivariate data with correlated variables into with uncorrelated variables. The new variables are obtained as linear combinations of the existing variables. PCA technique has used for many purposes like in image encoding, image fusion, image data compression and image enhancement. In the fusion process, PCA method generates uncorrelated images. The first principal component is replaced with the panchromatic band, with one which has higher spatial resolution. Finally the inverse PCA transformation is applied to obtain the image in the RGB colour image. Limitation of it is PCA image fusion method dominant spatial information and weak colour information is often a Problem. Anumolu Lasmika, K. Raveendra [5] author proposed a method for improving quality of satellite images. Author present a method, DWT to decompose the input image into different sub bands and apply threshold method on it. Identify the areas of the edges by using threshold decomposition method. After that the edges are sharpened by using morphological filters. This method works for sharpening and reduce the distortion of an image. Limitation of this work may be extended for other problems related to satellite images such as artifacts. Tonder et al. [10] proposed An effective method for improving the image quality is also introduced, in which a plotting utility, blend of universal and local conversion functions, is utilized which preserves the intensity and fine facts of the input image in addition. Contrast widening and Image intensity is preserved completely by universal conversion function. Fuzzy based enhancement is also applied to enhance the image. Sharpening filters are used in order to highlight fine details within an image. They are based on first and second order derivatives. Finally output of each stage is compared by using PSNR parameters. Aedla et al [12] have presented a new contrast enhancement technique for satellite images based on clipping or plateau histogram equalization. Their technique adopted Bi-Histogram Equalization with Plateau Limit (BHEPL) for image decomposition and Self-Adaptive Plateau Histogram Equalization (SAPHE) for threshold calculation. Their proposed method has been compared with existing methods such as Histogram Equalization (HE), Brightness Preserving Bi-Histogram Equalization (BBHE), Minimum Mean Brightness Error Bi-Histogram Equalization (MMBEBHE), Dynamic Histogram Equalization (DHE), Bi-Histogram Equalization with Plateau Limit (BHEPL) and Self-Adaptive Plateau Histogram Equalization (SAPHE) with image quality measures such as Absolute Mean Brightness Error (AMBE) and Peak-Signal to Noise Ratio (PSNR).

III. DIGITAL IMAGE ENHANCEMENT TECHNIQUES

In this section, different image enhancement techniques to improve or get the better quality of image to increase the perception or visibility are described below such as histogram equalization, filtering method, wavelet based and Image fusion method etc.

3.1 Histogram Equalization

The histogram equalization methods which transform the dynamic range & contrast level of an image such that its concentration histogram has a requisite shape. Histogram equalization [13] operators can be betrothed for non linear & non-monotonic transfer function for mapping between input and output images pixel intensity values. Histogram equalization utilizes a monotonic and non-linear mapping which re-assigns the flat histogram (uniform distribution of intensities) for the diverse intensity value pixels in the output image as well as input image. This method is using for image comparison & correction in the non linear process. (Because it is using to enhance the image quality), which introduced by a digitizer or display system improvements.

If we transform the input image to get $s = T(r)$

Here represents the probability density function of Ps and Pr respectively then Ps can be represented by a simple formula

$$\mathrm{P_s}(\mathrm{s}) = \mathrm{P_r}(\mathrm{s})\frac{\mathrm{dr}}{\mathrm{ds}} \qquad (1)$$

Where $r = T^{-1}(s)$

Consider the transformation

$$S = T(r) = \int_0^r P_r(W)\,dw \qquad (2)$$

Known transformation function T(r) we can get Ps so that Ps(s) tracks nearly uniform distribution which results in histogram equalized image. Histogram equalization increases the intensity values up to its self-motivated range as well as it flatten the histogram. In many images we found the satisfactory result using histogram equalization technique but sometimes it over enhance the image due to its global treatment.

3.2 Discrete Wavelet Transform (DWT)

The discrete wavelet transform (DWT) [14] is an accomplishment of the wavelet transform using a detached set of the wavelet scales for numerical analysis and functional analysis. A time-scale depiction of a digital signal is obtained using digital filtering method. In the detached wavelet transform, filters of unusual cut-off frequencies are used to investigate the signal at different scales. If the wavelets are discretely sampled, the resulting coefficients are called as discrete wavelet transforms (DWT) [15].

$$f[n] = \frac{1}{\sqrt{M}}\sum_k W_\varphi[j_0,k]\varphi j_{0,k}[n] + \frac{1}{\sqrt{M}}\sum^{j=j_0\infty}\sum_k W_\varphi[j,k]^\varphi j,k[n]$$

(3)

$$W_\varphi[j_0 - k] = \frac{1}{\sqrt{M}}\sum_n f(n)\varphi_{j_{0,k}}[n]$$

(4)

The signal is worked out by a series of high pass filters & a series of low pass filters to investigate the high frequencies & the low frequencies of the detached time domain signal, which is shown in figure-1. This is called the Mallat algorithm or Mallat-tree decomposition [16].

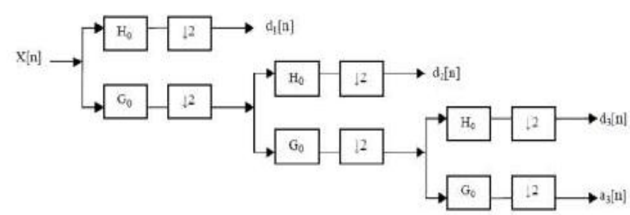

Figure.1 Three- level wavelet decomposition tree

In the figure.1, the signal is denoted by the sequence x[n], where n is an integer. The low pass filter is indicated by G0 while the high pass filter is denoted by H0. At each level, the high pass filter generates brief information d[n], while the low pass filter associated with scaling function produces coarse approximations, a[n]. This decomposition is recurring to additional augment the frequency resolution and the projected coefficients divided with high and low pass filters and then down-sampled. This is corresponds to as a binary decomposition tree with nodes representing a sub-space with diverse time-frequency localization. The tree is acknowledged as a filter bank.

3.3 Stationary Wavelet Transform (SWT)

One of the flexible tools for recent image processing is the Stationary Wavelet Transform (SWT) [11] distant from (DWT).This tool is very useful in image processing applications such as facial reconstruction, super resolution, video enhancement and multiple description coding etc. In this, estimated high frequency LH, HL and HH sub band images along with low resolution input image is measured for winning IDWT to generate high resolution image. Bi-cubic interpolation technique is used for image resolution enhancement. Bi-cubic interpolation produces smoothened edges with less blurring as compared with other interpolation techniques. High frequency component of satellite image is conserved by using SWT. This method has more complexity as compared to DWT, though; SWT minimizes loss and produces smoothened images.

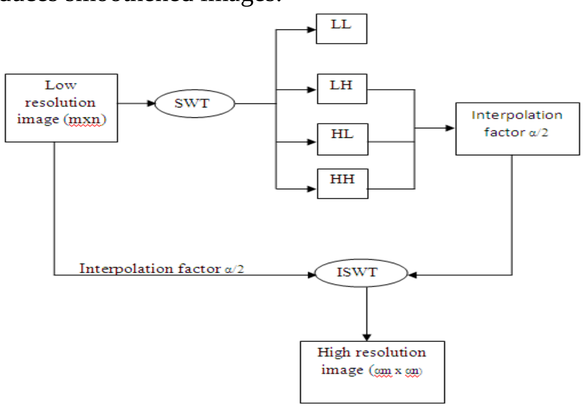

Figure 2: Block Diagram of the SWT-based Resolution Enhancement
method

3.4 Median filter

The Filtering is a ingredient of image enhancement which is used to augment definite details such as edges in the image that are pertinent to the application. In addition to that, filtering can also be used to eradicate unwanted elements of noise. Images generally contain salt and pepper noise. This noise appears due to the occurrence of minute gray scale variations in the image. Median filtering is a well-liked technique of the image enhancement for removing impulse noise exclusive of efficiently reducing the image sharpness [17]. Median filter is quite common because it provides excellent noise-reduction abilities, with basically less blurring than similar size linear smoothing filters. Here, the median process was performed by sliding a 3×3 windowing operator over the image. It considers every pixel and its neighbors in images to find out whether or not it is a representation of the surroundings. It replaces the value of pixel with the median of the neighboring pixel elements. We calculated the median by sorting the whole pixel values from the neighborhood into numeral sort and then replaced the pixel being studied with the middle pixel value. If the locality under condition constitutes an even pixels value, the average of the two middle pixel values is the median.

3.5 Unsharpmask filter

Unsharp filtering is an uncomplicated sharpening process that gains its name from the study which it improves edges and other high frequency components in images through a process that deducts a smoothed or unsharp version of images from the input images. In our study, the use of the classical unsharp masking filters after median filter to reduce of the remained noise and sharpen the edges. Firstly it is obtained a blurred form of the original image. This is carried out by applying the low-pass filter, in our case Gaussian blur algorithm using a small radius. We used a two pixel radius and applied Gaussian blur filter only two times [3]. The blurred form of the image is then pixel deducted from the original image and so it is obtained the high pass component. The output image is obtained by adding the high-pass component to the original image. Because the output image could contain also pixels with negative values, it is then normalized. No threshold cutoff was used. The two steps for the unsharp mask filter are
mentioned below:

- Unsharp mask filter creates edge images g(x, y) from input images f(x, y) in this Eq. 5.

$$g(x,y) = f(x,y) - fsmooth(x,y) \quad (5)$$

Where, $fsmooth(x,y)$ is a smoothed form of f(x, y) as shown in figure 1.

- An edge images from the consequence of subtracting input images from low pass signal could be utilized for images sharpening by adding it backward into the input signal, as demonstrated in Fig. 2. This function is represented as follows:

$$fsharp(x,y) = f(x,y) + k * g(x, y) \quad (6)$$

Where, k is a scaling constant, values for k ($k \geq 0$), for generally. When k>1, the process is referred to as high boost filtering. In our process, we have applied k=1.

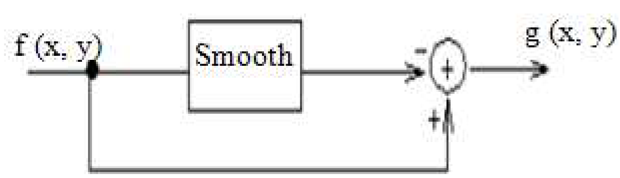

Figure 2: Spatial sharpening

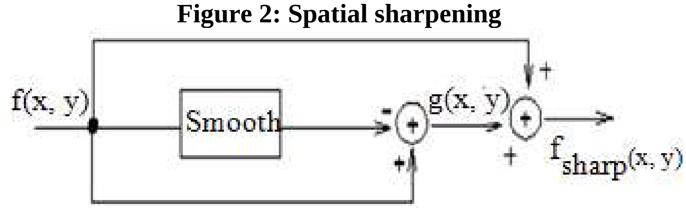

Figure 3: The complete unsharp filtering operator

The basic advantage of the unsharp filtering over other sharpening filters is the control flexibleness, because a vast majority of other sharpening filters do not supply any user-adjustable parameters. Unsharp filtering as other filters enhances fine detail and edges in digital images.

3.6 Cubic Spline Smoothing

Spline interpolation is perceived to be user friendly to wide gamut of industrial applications. For example, cubic spline representation has been the popular tool in various computer-aided modeling applications such as aircraft, automobile and ship design where the design of precise and smooth shape is of utter importance. Prior to the advent of spline art, designers have to use flexible ruler to draw smooth curves for their product design, which is subjected to human error. Moreover, spline could play vital role in estimating the chemical rates of change and analyzing large scale of numerical data obtained from experiments accurately. Hence, we use spline interpolation to design smooth curve that could taper large pixel intensity fluctuation in MR image of knee. Cumulative density function is sine qua non for the construction of transform function. To initiate HE, luminance levels available in MR knee image are interpreted as random variables in the range [0, L−1]. The probability density function, which is invariably described through histogram, is used to estimate the distribution of the random variables.

The cumulative density function, as illustrated in Figure 2, is derived from the probability density function and then used to remap the intensity distribution to enhance the contrast. Since transform function derived from statistical information considers only original cumulative density function as the medium to remap the distribution of luminance level, additional effort is necessitated to ensure the transform function does not lead to excessive brightness enhancement of the MR knee image.

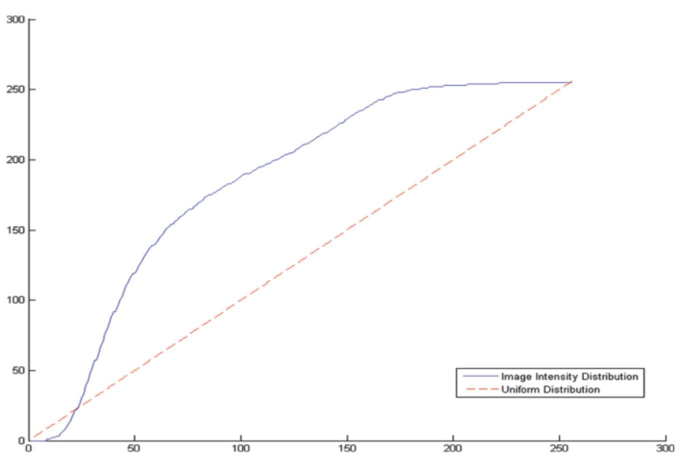

Figure 4. Cumulative density function (blue line) of MR image relative to uniform distribution (red dotted line). For illustration, up arrow indicates sharp intensity increment in output image as a result of traditional histogram equalization, which led to over-enhancement

3.7 Power-Law Transformation

This transformation shows the relation between pixels of f(x,y) and g(x,y) that is of original and enhanced image. General notation used in this transformation is:

$$s = cr^{\gamma} \qquad \text{(v)}$$

Or it can also be understood as:

$$I\ output\ (i, j) = c\ (\ I\ input\ (i, j)^{\gamma})$$

In Power Law Transformation each pixel value is raised to fixed power. This transformation is used for converting small and dark range of input pixel into larger and brighter range of output pixels or vice-versa. In equation *(v)*, c and r, are positive constants, possible transformations can be obtained by varying the values of r and keeping c= 1; r results in increasing the contrast of certain regions in input image with high value against low regions.

3.8 Threshold transformation

Threshold transformation is used in the areas where image needs to be segmented. In this the desired portion of the image is separated from the background [18]. If f(x,y) is the original image and g(x,y) is normalized or processed image then we can easily locate threshold image because it possess pixel value of ‘0’ or ‘1’.

IV. Conclusion

With the development of digital image data it becomes very essentials that the image should be clear and easy to visualize. To obtain the essential information related to geographical or communication data the satellite image data must be clear and having high resolution. This paper presented the literature about the former work done in the field of satellite image enhancement and also discusses the image enhancement techniques of digital image processing. After reviewing these techniques it is analyze that the use of hybrid approach is much more effective to obtain the clear and highly resolution image.

REFRENCES

[1] P. Suganya, N. Mohanapriya, B. Kalaavathi, “Satellite image resolution enhancement using multi wavelet transform and comparison of interpolation techniques”, International Journal of Research in Engineering and Technology, eISSN: 2319-1163 | pISSN: 2321-7308, Volume: 03 Special Issue: 07 | May-2014.

[2] Vaibhav R. Pandit, R. J. Bhiwani, “Image Fusion in Remote Sensing Applications: A Review”, International Journal of Computer Applications (0975 – 8887) Volume 120 – No.10, June 2015.

[3] Deepali M. Bongulwar “Satellite Image Enhancement”, International Journal of Application or Innovation in Engineering & Management (IJAIEM), Volume 6, Issue 6, June 2017.

[4] Wenkao Yang, Jing Wang and Jing Guo, “A Novel Algorithm for Satellite Images Fusion Based on Compressed Sensing and PCA”, Hindawi Publishing

Corporation, Mathematical Problems in Engineering, pp. 1 – 10, Volume 2013.

[5] Lasmika, K. Raveendra, "Improving Quality of Satellite Image by Wavelet Transforming & Morphological Filtering", International Journal of Innovative Research in Science, Engineering and Technology, ISSN: 2319-8753,Vol. 3, Issue 7, July 2014.

[6] Khaled SAHNOUN, Noureddine BENABADJI "On-Board Satellite Image Compression Using The Fourier Transform And Huffman Coding"

[7] Xue Mei Li "Image Enhancement in the Fractional Fourier Domain" in proceeding IEEE, 2013.

[8] Bhateja, V. "Improvement of masses detection in digital mammograms employing non-linear filtering", Automation, Computing, Communication, Control and Compressed Sensing (iMac4s), 2013 International Multi-Conference on March 2013, Page(s): 406 – 408.

[9] Zouari, M. "A non linear stretching image enhancement technique for micro-calcification detection", Advanced Technologies for Signal and Image Processing (ATSIP), 2014 1st International Conference on March 2014, Page(s): 193 – 197.

[10] Vijay Tonder, Vivek Shukla2, Rohit Miri "Improving Quality of Satellite Images Using Enhancement Filters and Fuzzy Based Contrast Enhancement Technique", International Journal of Innovative Research in Computer and Communication Engineering.2017

[11] Mansing Rathod, Jayashree Khanapuri "Satellite Image Resolution Enhancement Using SWT and DWT with SWT", International Conference on Nascent Technologies in the Engineering Field (ICNTE-2017) in proceeding of IEEE.

[12] R. Aedla, G. S. Dwarakish and D. V. Reddy, "Satellite image contrast enhancement algorithm based on plateau histogram equalization," Region 10 Symposium, 2014 IEEE, Kuala Lumpur, 2014, pp. 213-218.

[13] Sos S. Agaian, Blair Silver and L. Karen A. Panetta, "Transform coefficient histogram-based image enhancement algorithms using contrast entropy" IEEE Trans. On Image Process, vol. 16,no. 3, Mar. 2007.

[14] Hasan Demirel and Gholamreza Anbarjafar, "Discrete Wavelet Transform-Based Satellite Image Resolution Enhancement" IEEE Transactions On Geoscience And Remote Sensing, Vol. 49, No. 6, June 2011.

[15] R. C. Gonzalez and R. E. Woods "Digital Image processing (2nd Edi- tion)". Prentice Hall, January 2002.

[16] Mallat, S.G. "Multifrequency channel decompositions of image and wavelet models ", IEEE Trans. Acoust. Speech Signal Process., 1989, 37, (12), pp. 2091–2110

[17] Chan, R.H., C.W. Ho and M. Nikolova "Salt-and pepper noise removal by median-type noise detectors and detail-preserving regularization.

[18] Mohanapriya N, Kalaavathi B "Comparative Study of Different Enhancement Techniques for Medical Images" International Journal of Computer Applications, 2013; 61(20).

Authors Profile

Kshipra Singh *pursuing* Master of Technology in Computer Science and Engineering. Computational Sciences, Department of Computer and science, from University of Taiwan, Taiwan since 2012. He is a member of IEEE & IEEE computer society since 2013, a life member of the ISROSET since 2013, ACM since 2011. He has published more than 20 research papers in reputed international journals including Thomson Reuters (SCI & Web of Science) and conferences including IEEE and it's also available online. His main research work focuses on Cryptography Algorithms, Network Security, Cloud Security and Privacy, Big Data Analytics, Data Mining, IoT and Computational Intelligence based education. He has 5 years of teaching experience and 4 years of Research Experience.

Mr Jijo S.Nair is working as a professor in Oriental Institute of Science and Technology, Bhopal in Madhra Pradesh. Bachelor of Science and Master of Science from University of New York, USA in year 2009. He is currently pursuing Ph.D. and currently working as Assistant Professor in Department of Telecommunication, University of New York, USA since 2012. He is a member of IEEE & IEEE computer society since 2013, a life member of the ISROSET since 2013 and ACM since 2011. He has published more than 20 research papers in reputed international journals including Thomson Reuters (SCI & Web of Science) and conferences including IEEE and it's also available online. His main research work focuses on Cryptography Algorithms, Network Security, Cloud Security and Privacy, Big Data Analytics, Data Mining, IoT and Computational Intelligence based education. He has 5 years of teaching experience and 4 years of Research Experience. Cryptography Algorithms, Network Security, Cloud Security and Privacy, Big Data Analytics, Data Mining, IoT and Computational Intelligence based education. He has 5 years of teaching experience and 4 years of Research Experience.

