

CNN Based Image Quality Improvement in Handheld Ultrasound Device

Dr. R. Niruban¹, Deepa.R.²

¹Associate Professor, Department of Electronics and Communication Engineering,
St. Joseph's College of Engineering, Chennai.

² Assistant Professor, Department of Artificial Intelligence and Data Science,
Anand Institute of Higher Technology, Chennai.

Abstract - As ultrasound methods seem to be more precise, they are now increasingly popular in the healthcare industry; yet, the quality of the image in portable ultrasound tools is relatively poor. Convolutional Neural Networks are used in the proposed method to increase the visual norm in mobile handsets to higher views. Convolutional Neural Networks were proposed to preprocess in portable gadgets, leading to high sights. The median filter is being used in histogram equalization to decrease unwanted noise and keep the features whilst ensuring a high spectral response. The histogram equalization method is also used to change the dynamical value's histogram. To boost picture sharpness, it stretches out the most prevalent pixels or expands out all the image's intensity value. Unsharp masking, despite to its name, is a technique for sharpening an object. When post-processing any digital photographs, sharpening is vital as it tends to emphasize information. A Convolutional Neural Network is frequently used to achieve better precision. CNN was designed specifically to deal with picture element. It's a supervised classifier that creates a structure, analogous to a pipeline, but then just generates a completely associated surface in which all the layers are joined and also the result is examined. It could provide highly designed and programmed training as well as provide a greater restoration vision of minute details, shape, and dispersion by using CNN.

Index Terms - Hand-held ultrasound device, Convolutional Neural Network ,Image enhancement , Median filter , Histogram Equalization ,Unsharp masking.

I. Introduction

It is approach of amplifying or obtaining data from a shot by accomplishing actions on it. Classical and automated are indeed the two main pattern of form analyses. Automated data pre-processing mainly deals with 2D indication and needed analog inputs. The approach of adopting a software program to modify bitmap images that used a technique is referred to as image information analysis. Image technique is a kind of painless analytic data. It makes constant photographs or video of inward organs or different tissues, for example, blood supply routes, utilizing high-recurrence impulse transmits. The converter discharges send signal into your skin, assembles them, and moves them to a PC, which produces illustrations. PC related gadgets, hand conveyed (HCU), and portable (HHUSD)[1] frameworks are the 3 kinds of convenient imaging gadgets. In this model, the Convolutional Neural Network method

is utilized.; it connects with the utilization of man-made reasoning calculations to

observe designs in informational collections with information focuses that are hardly grouped, labelled. In the tract of picture enhancement ,the most critical obligation is picture recuperation. The picture is regularly debased, making clutter to show up in the picture. The middle channel is regularly implied to lessen the appearance of certain commotion, but it functions admirably for pictures with generally twenty percentage clamor force. Along these lines, to accomplish a superior picture reclamation, we can utilize one more picture rebuilding approach known as versatile middle separating, which is compelling for commotion forces more noteworthy than 20%. The benefit of a versatile channel over a middle channel is that it doesn't obliterate the picture's outlines or specific elements. The versatile channel operates in two stages: initially, it tracks down the piece's middle

worth, inspect. If a pixel's value is tampered with, it either preserves the value from the black size unit or substitutes it with the neutral point. The centre circuit is the one that is usually frequently used. A regressive separation method is used. A $m \times m$ distorted image is intended to be added to or floated over the centre, which may be $n \times n$ pixels in size. Using technique, the value of a particular pixel is substituted for the centre value of the $n \times n$ section of the image. [2]. Because an MRI scan includes the greatest information about a condition, professionals require reliable, discrepancy images to examine these conditions and improve patient care. Higher image particle localization is needed because MRI images' poor luminance makes diagnosis challenging. Spectrum normalization techniques aid in the enhancement of images, resulting in increased graphical fidelity and a distinct dilemma. The luminosity and distinction have been preserved while preventing the loss of the input values. We had a glimpse at those levelling techniques that are primarily investigated in this study[3]-[9]. Security, reconnaissance, and surveillance are just a few applications where indigo and discernible images have been combined. The use of frequency modification demonstrates the necessity of chromatic aberrations coverings for sensory fusion. Discrete wavelet transform completes the decomposition of evidence images (infrared, apparent). The estimated values and indications of the parameters. Employing evaluation criteria, unfocused concealment was used to enhance Brilliance. From such a moment on, the evaluation limitations that were gathered following chromatic aberrations protective coating are combined using the screening using computations. The best convergence rule applies to unify minute borders. Ultimately, IDWT is used to create a composite image. The provided mixture produces significant differences and superior performance appropriate levels of norm, volatility, and significance variance when compared to the results obtained by applying hybrid method. An image enhancement technique called "Gaussian blur overlaying". Consider $f(l,k)$ to be a signifier, $f_s(l,k)$ to be a refined version of $f(l,k)$, and $f(l,k)$ to become a murky version of $f(l,k)$ (l,k). The visual cells planned performance data from several sources using the gathering computation.

This strategy doesn't make any adjustments. A range of graphical informative descriptors are provided to examine how different CNNs convey their content. Models trained samples for determining the appearance of a cortical neural activity include Auto encoder, CIFAR10[10], CIFAR 100[11], and MNIST [12] visual material compilations. We listed from the most obvious bits of info Throughout our interrogations: ImageNet, CIFAR10, and CIFAR100, as assessing a site's competency on a particular document doesn't quite reveal its maximum ability and Threshold level. It should be highlighted that tapes are used as evaluations rather than instruction assessments [13]-[18]. Classification methods (Convolutional Neural Network) were primarily developed for the interpretation of pixels. The goal of graphic enhancement is to render a vision more useful for a certain action, such as trying to enhance to the visual system aesthetically. Renovations are employed to make improving perceptual Comprehension and enjoyment easier. In order to improve the overall content of an affective scene for diagnostic testing and emphases noteworthiness, comparison improvement is a fundamental component of any sentimental screen resolution inspection.

The section II explains the background information about the paper, section III explains the proposed methodology, section IV explains the results and discussion and section V explains the conclusion.

II Background

Magnetic Resonance Imaging (MRI) is a medical imaging technique used for analyzing and diagnosing diseases such as cancer or tumour in a brain. Inorder to analyze these diseases, physicians require good contrast scanned images obtained from MRI for better treatment purpose as it contains maximum information of the disease [19]. MRI images are low-contrast images which lead to difficulty in diagnoses, hence better localization of image pixels is required. Histogram equalization techniques help to enhance the image so that it gives an improved visual quality and a well-defined problem. The contrast and brightness [20] are enhanced in such a way that it does not lose its original information and the brightness is preserved.

The benefit of adaptive filter over median filter [21]-[23] is that it does not erode away edges or small details in the image. The working of adaptive filter is a two-step process; in the first step it finds the median value for the kernel and in the second step it checks whether the current pixel value is a impulse or not. If pixel value [24] is corrupted then it changes it value with median or else it retains the value of the gray scale pixel. Median filter is the most commonly used filter. It is a nonlinear method of filtering. The size of the kernel can be of $n \times n$ size which is made to convolve or slide over a $m \times m$ corrupted image. By creating a single wave front while concentrating, wave function screening, a common rapid diagnostic neuroimaging technique, attains detection frequency. The image resolution, however holds up remarkably well when compared to the frequently used centered flexible component configuration can improve pixel density at the expense of additional processing. To strengthen PWI while having a high construction rate, fundamental neural systems are used. The information from the national is the PWI signals from highly accurate target, and the outcome indication is the focused return response from a nearby point.

The zone of periodicity Instruction uses RF data [25] and responses from the focused emission. The data is a statistical model that is sent to a quadratic transform, then after DNN is trained and the periodicity and significance are returned to the temporal domain. These businesses convert PWI RF data into appropriate centred response may be used to create a high-quality B-mode sonar image.

III. METHODS

3.1 Method Overview

CNN is frequently used to replace inferior photographs taken by modern cellular telephone. To handle pictures in a way that is determined for data point, a nonlinear neural organization (CNN) [26] is used. The 3 layered networks consist of a fully connected, a pooling layer, and a convolutional layer. In view of pattern recognition, it is a controlled network. In order to reduce distortion caused by damaged data, the central stream is frequent used in Information structures management. A retrograde approach to minimize Resistivity is intermediate separation, often known as salt-pepper tone

reduction. The effect modification of an intermediate unit getting evaluated, which moves all along border, is comparable visual intensity of the images contained within the enclosure. Contour equalization [27] is used to accomplish the goal of brightness and sharpness. By employing the distribution, the quantization technique alters the strength of a visual.

It expands the photo's spectral response or distributes the most common data point to promote the beauty of the image. Sharpening of images Chromatic aberrations screening produces a sharper image when the value is increased. The initially assumed mega can be achieved by converging a medium (vorable) collection of photographs of a Circumstance into a rather higher image or portrait sequence. As a result, it makes an effort to recreate definitely the best landscape image from a collection of generally underappreciated photos.

3.2 Denoising

It is used to portray picture separating strategies in which both the info and result pictures are force pictures at the most minimal degree of reflection. Eliminate clamor is a strategy to increment picture information by eliminating undesirable disfigurements or expanding a part of the picture that is significant for post handling. Picture pre - handling the techniques exploit the significant redundancy in pictures. One of the pre-handling approaches is picture cleaning.

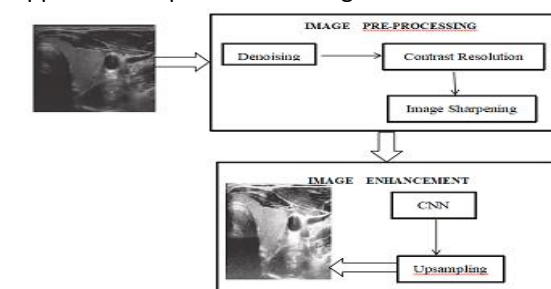


Fig 1: System Architecture

Figure 1 illustrates the overall system architecture. Channels are utilized to change or intensify visual attributes as well as get experiences from photos, like limits, edges, and masses. Deeply, which is a little framework treated to each adjoining pixels inside an image. Middle channels are helpful for decreasing encompassing clamor when the

unsettling influence extent likelihood thickness work has enormous furthest points and redundant trends. The middle sifting process is done by floating an edge in an approximation noise indication, the center represents the spot with the highest likelihood assessment. Because it measures the diversity for connecting with the proper locations, the centre route performs marvelous in the stretched gazed ruckus. One aspect of the frame leads where a boundary is touched, and the outcome suddenly switches in between attributes.[28] As a result, the margin is not altered. Each row and fragment of the image is copied to use the image duplication technique, and a bare center cloud is then flown throughout each row and cell. It serves as,

$$g(x,y)=h(x,y)+n(x,y) \text{ -----(1)}$$

Usually, the original images are used to evaluate how hidden the resulting darkened units. The enhanced image is frequently diminished when photos are enlarged in this way.

3.3 Contrast Resolution

The capacity of any figuring approach to segregate among contrasts in shot force is alluded to as difference goal in fluoroscopy. The inherent differentiation [29] nature of a computerized picture is characterized by how much particular adjoining pixels, which would be determined as how much pieces per data of interest. Unreasonable splendor debases picture nature. The vivid portrayal of a picture's element power ideals is known as a bar graph. It's the information model that monitors the frequencies of all the picture's pixel power levels. This is achieved utilizing factual coordinating, which permits the picture's diminished regions to arrive at more noteworthy force. Histogram adjustment is utilized to compute the scale factor while keeping up with data virtue. The techniques portrayed can be utilized to edit the chromatic by using eqn(2):

$$G(x,y)=h'(x,y)+b$$

$$G(x,y)=h'(x,y)-b \text{ -----(2)}$$

In a bar chart adjusting, the x hub shows the dim range byte power, while the y hub mirrors the impact of different steps. The thickness of a point is

its chromatic. As opposed to the outline delineates variety of picture point are at a specific degree of power. Pictures are put away in a PC as a variety of steps, which are suggested as contiguous points. These board score demonstrate the chromaticity of the board. Highly contrasting is addressed by the numbers 0 and 255, likewise.

3.4 Image Sharpening

It's a strategy for improving a picture's clear sharpness. Photoshop can't mystically fix additional subtleties once a picture has been caught; the genuine goal stays fixed. As such, expanding acutance is the main technique to work on evident sharpness. You ought to increment edge difference to your picture in the event that you believe it should look more keen. minute information is accomplished by underlining the picture's outline and specialized viewpoints. To recognize any outlines, it takes away an obscured (unsharp) [30] duplicate from the first picture. This outline information is utilized to make a veil. The impact is then substituted to the first picture, with the differentiation expanded at the outlines. Thickening eliminates item from the edge to make a latest thickened outline, while sharpening keeps up with the thickness of the sharp edge by taking the blade's outline back to the centre. Unsharp concealing (USM) is an advanced picture upgrading strategy originally utilized in bad imaging and presently regularly utilized in picture handling method. The method's name comes from the way that it makes a veil of the first picture utilizing an obscured, or "unsharp," negative picture. From that point onward, the blurred veil is substituted to the information solid picture, creating in a very hazy data. Despite the fact that the picture seems clearer, this might not be a genuine portrayal of the thing by the eqn(3).

$$G(\text{unsharp})=h'(x,y)+G\text{mask}(x,y)$$

$$G\text{mask}(x,y)=h'(x,y)-g(x,y) \text{ -----}$$

(3)

Blurred Mask makes a mutilated portrayal of the picture that is then subtracted from the genuine data utilizing an information channel.

3.5 Image Enhancement

Nature of a picture is the strategy of fortifying the capacity of preferable review to understand or significant sign in pictures while at the same time giving 'better' information than those other mechanized picture examination methodology. The central objective of picture improvement is to alter the characteristics of a picture to make it more OK for a predefined reason and onlooker. As a result of this method, one or many picture ascribes are adjusted. The qualities picked and how they are changed are task-explicit. CNN was made in view of pixel information. The CNN is illustrated in figure 2 which involves a progressive model that forms an organization looking like a pipe and afterward yields a completely associated stages. Significantly, a CNN has three layers: Convolutional network, Pooling network, fully associated network.

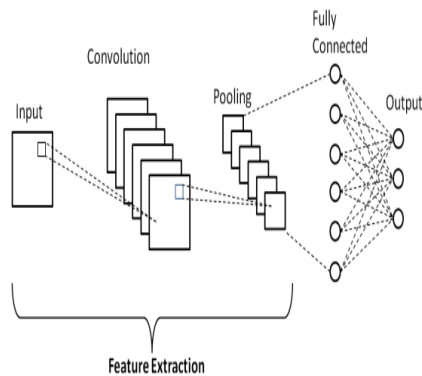


Figure 2. CNN layer Classification

3.5.1 Convolutional layer

A network with the accompanying parts is taken care of into a CNN: (measure of data sources) $\times$ (source level) $\times$ (source width) $\times$ (source channels). The picture is disconnected to a component map, otherwise called an enactment map, in the wake of going through a convolution network, with the accompanying structure: (measure of information sources) $\times$ (include point level) $\times$ (highlight point width) $\times$ (include point channels). The income is processed by convolution network, The result is in this manner gave to the following level. This is comparable to a neuron's reaction to a solitary upgrade in the visual cortex. Each convolutional neuron just cycles information for the open field it is allotted to. Albeit completely connected feed forward brain organizations can be utilized to recognize faces and classify information, this engineering is unsatisfactory for greater data

sources like high-goal photographs. Because of the huge size of the contribution of pictures, where every pixel is a significant information trademark, it would require an exceptionally enormous number of stowed away neurons, even in a shallow design. For instance, every cell in the second layer of a convolution layer for a (little) example picture 100 by 100 has 10,000 loads. Convolution, then again, decreases how much pieces of information, taking into account a more profound stage. Since matrix connections among various highlights, neural brain stage is proper for information with a lattice like engineering.

3.5.2 Pooling layer

The component guides' aspects are decreased by utilizing pooling stages. Subsequently, the arrangement of factors to learn is decreased, similar to the quantity of calculation performed in the organization. The elements occupied in a space of the information bank created by a stage 1 are summarized by the stage 2. Therefore, as opposed to exactly situated highlights made by the convolution layer, following activities are led on summed up highlights. Thus, the network is more impervious to transform in the place of components in the initial pictures. Stage 2 that chooses the most noteworthy part from the region of the information bank masked by the channel is called as maximum pooling. Eventually, maximum pooling stage, the result will be an element point involving the main highlights from the first stage.

Algorithm: 1 Pseudocode of proposed CNN

```

Input: Publicly available thyroid scan
datasets
Output: High resolution image with
accuracy values
Begin
1. Boolean false
2. Set x,y,gray
3. Set as_gray=false; /*
Initialize a boolean value*/
4. For x = 1 to size do /* Size
of the image*/
5. Function
imread(img_shape,x,y)
6. Import skimage
7. Import matplotlib /*for
plotting the x axis and y axis of
the image*/
8. Read the input image
9. Apply median filtering /*
Denoising process */
10. Allow thresholding to
enhance the image
/*Enhancing the image after
segmentation*/
11. Plot x axis and y axis
12. Convert RGB to HSI color
space

```

3.5.3 Fully Connected layer

In a brain organization, completely connected stage will result from initial level are linked to each enactment square of the following stages. The last couple of stages in most run of the mill AI models are full associated layers that accumulate the information recovered by going before layers to create the last result. The result of the completely associated layers shows the likely highlights of the information [31]-[36]. Albeit the secret stages will be leveled and associated with the result cell, additionally a thoroughly stages permit indirect combinations of these attributes for a (generally) minimal expense. The last stages of a deep learning are totally associated stages. A network is associated network are totally connected with the

excitement of the resulting layer's neurons. Then again, these totally associated layers can acknowledge one bunch of information. To switch our 3D information over completely to 1D, we utilize Python's compliment work. Our muti volume is successfully decreased to a single vector.

IV. Result and Discussion

The convolution mind association to overhaul the idea of the data of palm ultrasonic gadgets with a quicker reaction rate has been suggested. By decreasing upheaval and the suggested method for changing the item's luminance system hopes to outfit high exact readiness with increased precision and make a significant standard modifying picture with post processing plan and speck. Moreover, the increasing the number of megapixels enhances. and supporting the data objective. From figure 3, the noise removal framework is done through an adaptable center channel through a center filter. The progressed channels can't accomplish some sign taking care of endeavors, however flexible channels can. Convolutional cerebrum associations (R-CNN) areas can be discovered for zeroing in blundering on the tortured locale and dealing with.

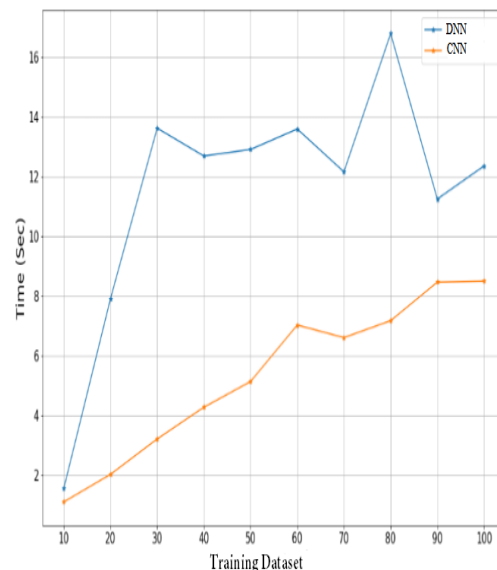


Figure 3. Performance evaluation of CNN and DNN response time

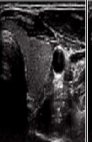
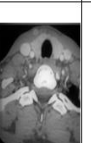
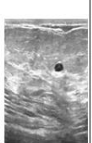
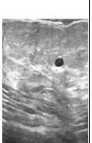
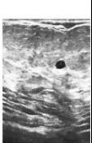
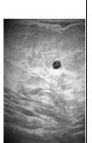
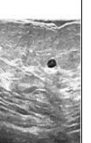
Input	Denoising	Contrast Resolution	Image Sharpening	Image Enhancement	Accuracy
					93%
					95%
					92%
					95.7%

Figure 4. Dataset Comparison with accuracy

The figure 4 illustrates the various datasets with accuracy performance measure.

The report forms a permanent account of a patient's illness. Their clarity and accuracy [37] are paramount for effective communication between healthcare professionals and patients. A structured format incorporating elements of background information, physical examination, specimens obtained. The normal values of thyroid uptake of radio tracer are 3 to 16% at 6 hours and 8 to 25% at 24 hours. size of normal thyroid gland: 100-480, volume of normal thyroid gland: 700 -1000, weight of normal thyroid gland: 1- 20These values may change according to laboratory standard techniques or patient dietary habits. The thyroid gland can uptake more or less than normal. A normal thyroid scan would show no abnormalities in the size, shape, and location of the thyroid gland.

Report Generation

```

Size of normal thyroid Gland: 100-480
Volume of normal thyroid Gland: 700-1000
Weight of normal thyroid Gland: 1-20
Observed reading
Size of thyroid Gland: 600
Volume of thyroid Gland: 800
Weight of thyroid Gland: 3
Result:
Thyroid detected

```

Figure 5. Neural network balanced accuracy

An abnormal thyroid scan may show a thyroid that's enlarged or out of position, indicating a possible tumor. Abnormal measurements also may show that your thyroid gland collected too much or too little of the radio nuclide [38]-[41]. Every single available detail is important because all accumulated information can contribute to diagnosis and treatment. Every human might not have medical knowledge, hence by giving report in readable format inspite of resultant image they would get some idea of what the test result is, and get further treatment according to it. A medical report form is a document used by medical professionals for documenting a patient's medical treatment in figure 5.

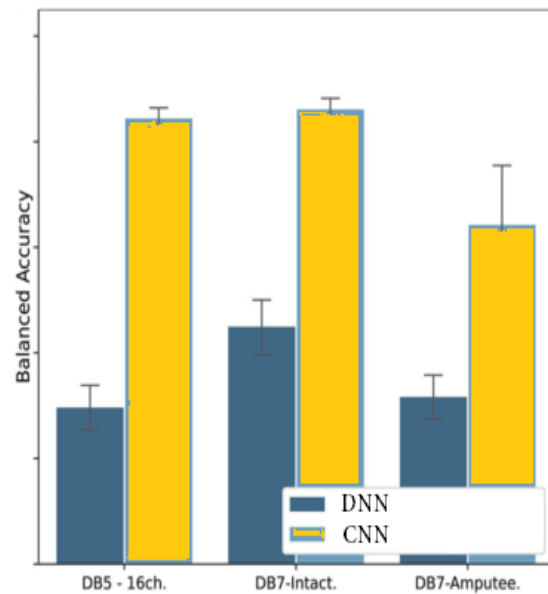


Figure 6. Neural network balanced accuracy

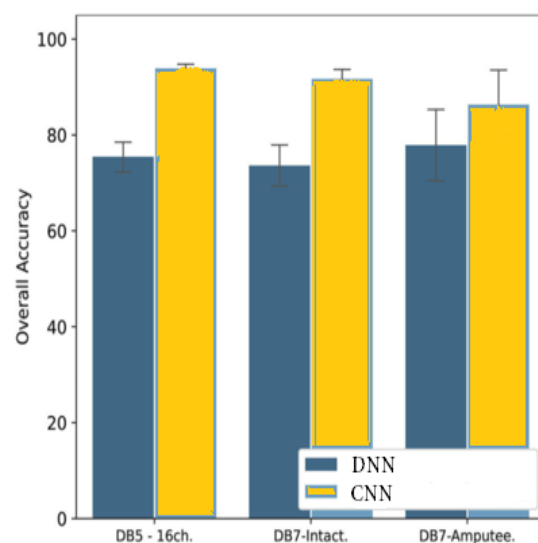


Figure 7. Neural network overall accuracy

v Conclusion

The utilization of a neural brain organization to upgrade the nature of the picture of palm ultrasonic gadgets with a quicker reaction response has been discovered. By lessening commotion and modifying luminance in the picture, the discovered strategy looks to furnish most precise preparation with increased exactness and make a goal rebuilding picture with post processing design and dot. Furthermore, the picture is achieved by summing various point and supporting the picture's goal. The noise removing system will be finished utilizing a versatile middle channel over a middle filter. Traditional advanced channels can't achieve some sign handling undertakings, though versatile channels can. Convolutional brain organizations (R-CNN) districts can be discovered for focusing erring in the tormented region and handling.

References

- [1] Hetvi Soni, Darshana Sankhe, "Image Restoration using Median Filtering," Volume: 06 Issue: 10 ,Oct 2019.
- [2] Omprakash patel,Yogendra P.S Maravi,Sanjeev Sharma,"A Comparative Study of Histogram Equalization Based Image Enhancement Techniques for Brightness Preservation and Contrast Enhancement," Signal & Image Processing An International Journal,November 2020.
- [3] Sumanth Kumar Panguluri,Laavanya Mohan,"Discrete Wavelet Transform Based Image Fusion Using Unsharp Masking,"December 2019.
- [4] Di Fan, Shuai Fang, Guangcai Wang,Shang Gao, Xiaoxin Lin," The visual human face super-resolution reconstruction algorithm based on improved deep residual network," EURASIP Journal on Advances in Signal Processing, November 2019.
- [5] Tao Qiu, Chang Wen , Kai Xie , Fang-Qing Wen, Guan-Qun Sheng, Xin-Gong Tang ,"Efficient medical image enhancement based on CNN-FBB model," Volume 13, Issue 10, 22 August 2019.
- [6] Kuo Shiuan Peng, Fang Cheng Lin, Yi-Pai Huang, Han Ping D. Shieh,"Efficient super resolution using edge directed unsharp masking sharpening method,"Proceedings - 2019 IEEE International Symposium on Multimedia, ISM 2019.
- [7] Sushma L , Dr. K. P. Lakshmi," An Analysis of Convolution Neural Network for Image Classification using Different Models,"Volume 9, Issue 10, october 2020.
- [8] Robin Zatta, Ritesh Jain, Janusz Grzyb, Ullrich R. Pfeiffer," Resolution Limits of Hyper-Hemispherical Silicon Lens-Integrated THz Cameras Employing Geometrical Multi-Frame Super-Resolution Imaging ,"IEEE Transactions on Terahertz Science and Technology 2021.
- [9] Kaeser Md. Sabrin, Md. Haider Ali," An Intelligent Pixel Replication Technique by Binary Decomposition for Digital Image Zooming,"Image and Vision Computing ,December 2020.
- [10] Wei Ye, Kai-Kuang Ma," Blurriness-Guided Unsharp Masking," IEEE Transactions on Image Processing : a Publication of the IEEE Signal Processing Society, 01 Sep 2019.
- [11] P. M. Corry et al., "Human cancer treatment with ultrasound," IEEE Trans. Ultrason., Ferroelect., Freq. Control, vol. 31, no. 5, pp. 444-456, Sep. 1984.
- [12] 12.B. G. Ewigman, "Effect of prenatal ultrasound screening on perinatal outcome," N. Engl. J. Med., vol. 329, no. 12, pp. 821-827, Sep. 1993.
- [13] C. A. Linte et al., "Evaluation of model-enhanced ultrasound-assisted interventional guidance in a cardiac phantom," IEEE Trans. Biomed. Eng., vol. 57, no. 9, pp. 2209-2218, Sep. 2010.
- [14] J. M. Chang et al., "Experimental system prototype of a portable, low-cost, C-scan ultrasound imaging device," IEEE Trans. Biomed. Eng., vol. 55, no. 2, pp.519-530, Mar. 2008.
- [15] B. J. Kimura et al., "Usefulness of a hand-held ultrasound device for bedside examination of left ventricular function," Am. J. Cardiol., vol. 90, no. 9, pp. 1038-1039, Nov. 2002.
- [16] C. Martinoli et al., "Point-of-care ultrasound in haemophilic arthropathy: will the HEAD-US system supplement or replace physical xamination?" Haemophilia, vol. 22, no. 1, pp. 20-21, Dec. 2016.

- [17] 17.K. F. Stock et al., "Comparison of a pocket-size ultrasound device with a premium ultrasound machine: diagnostic value and time required in bedside ultrasound examination," *Abdom. Imaging*, vol. 40, no. 7, pp. 2861-2866, Oct. 2015.
- [18] T Sunder Selwyn, S Hemalatha, Condition monitoring and vibration analysis of asynchronous generator of the wind turbine at high uncertain windy regions in India, *Materials Today: Proceedings*, Vol. 46, pp3639-3643, 2021.
- [19] T. Sunder Selwyn, Formation, characterization and suitability analysis of polymer matrix composite materials for automotive bumper *Materials Today: Proceedings*, Vol. 43, pp1197-1203, 2021.
- [20] T Sunder Selwyn, R Kesavan, M.Ramachandran, FMECA Analysis of Wind Turbine Using Severity and Occurrence at High Uncertain Wind in India, *International Journal of Applied Engineering Research*, Vol.10, Issue 11, pp 10250-10253.
- [21] T Sunder Selwyn, R Kesavan, Sensitivity Analysis of Wind Turbine Availability and Its Sub Assemblies At High Uncertain Wind, *International Journal of Applied Engineering Research*. ISSN 0973-4562, Vol.10. Issue.10. pp.10225-10229. 2015.
- [22] B. P. Nelson and A. Sanghvi, "Out of hospital point of care ultrasound: current use models and future directions," *Eur. J. Trauma. Emerg. Surg.*, vol. 42, no. 2, pp. 139-150, Apr. 2016.
- [23] N. Kolbe et al., "Point of care ultrasound (POCUS) telemedicine project in rural Nicaragua and its impact on patient management," *J. Ultrasound*, vol. 18, no. 2, pp. 1-7, Jun. 2015.
- [24] D.M. Becker et al., "The use of portable ultrasound devices in low-and-middle-income countries: a systematic review of the literature," *Trop. Med. Int. Health*, vol. 21, no. 3, pp. 294-311, Dec. 2015.
- [25] A. Riley et al., "Utility of hand-held echocardiography in outpatient pediatric cardiology management," *Pediatr. Cardiol.*, vol. 35, no. 8, pp. 1379-1386, Dec. 2014.
- [26] S. Ahn et al., "Smartphone-based portable ultrasound imaging system: prototype implementation and evaluation," in *IEEE International Ultrasonics Symposium*, Taipei, Taiwan, Oct. 21-24, 2015, pp. 1-4.
- [27] R. Henderson and S. Murphy, "Portability enhancing hardware for a portable ultrasound system," U.S. Patent 9629606. Apr. 25, 2017
- [28] G. R. Lockwood et al., "Real-time 3-D ultrasound imaging using sparse synthetic aperture beamforming," *IEEE Trans. Ultrason., Ferroelect., Freq. Control*, vol. 45, no. 4, pp. 980-988, Jul. 1998.
- [29] G. Matrone, "The delay multiply and sum beamforming algorithm in ultrasound B-mode medical imaging," *IEEE Trans. Med. Imaging*, vol. 34, no. 4, pp. 940-949, Apr. 2015.
- [30] S. Huang et al., "Efficient contrast enhancement using adaptive gamma correction with weighting distribution," *IEEE Trans. Image Process.* vol. 22, no. 3, pp.1032-1041, Mar. 2013.
- [31] Niruban Rathakrishnan, and Deepa Raja, Optimized convolutional neural network-based comprehensive early diagnosis method for multiple eye disease recognition, *Journal of Electronic Imaging*, Vol. 31(4), 2022, DOI: 10.1117/1.JEI.31.4.043016.
- [32] S. Fu, "A compound anisotropic diffusion for ultrasonic image denoising and edge enhancement," in *IEEE International Symposium on Circuits and Systems*. Kobe, Japan, May. 23-26, 2005, pp. 2779-2782.
- [33] C. Wang and Z. Ye, "Brightness preserving histogram equalization with maximum entropy: a variational perspective," *IEEE Trans. Consum.*
- [34] D. Wu et al., "Deep dynamic neural networks for multimodal gesture segmentation and recognition," *IEEE Trans. Pattern. Anal.*, vol. 38, no. 8, pp.1583-1597, Aug. 2016. *Electron.*, vol. 51, no. 4, pp. 1326-1334, Nov. 2005.
- [35] G. Wu et al., "Scalable high-performance image registration framework by unsupervised deep feature representations learning," *IEEE Trans. Biomed. Eng.*, vol. 63, no. 7, pp. 1505-1516. Jul. 2016.
- [36] J. Shi et al., "MR image super-resolution via wide residual networks with fixed skip connection," *IEEE J. Biomed. Health*, 2019, Preprint.

- [37] J. Shi et al., "Super-resolution reconstruction of MR image with a novel residual learning network Algorithm," *Phys. Med. Biol.*, 63(8): 085011. Apr. 2018.
- [38] J. Hatvani et al., "Deep learning-based super-resolution applied to dental computed tomography," *IEEE Trans. Radiat. Plas. Med. Sci.*, Dec 2019.
- [39] Niruban, R., Deepa, R., Vignesh, G.D., A novel iterative demosaicing algorithm using fuzzy based dual tree wavelet transform, *Journal of Critical Reviews*, 2020, 7(9), pp. 141–145
- [40] Niruban, R., Sree Renga Raja, T., Deepa, R., Similarity and Variance of Color Difference Based Demosaicing, *International Journal of Applied Engineering Research*, 2014, 9(23), pp. 21657–21668.