2. Chapter-II: Review of Literature

The introduction to this research work is redirecting towards the previous work done in this field to affirm the motivation and need towards this work. It also attracts the nature of research methodology used previously and provides a direction for the methods and dimensions to be used in this research work. In this chapter the main dimensions playing vital role in this research work are being explored as much possible, to provide a correct direction.

2.1. Literature Review

Any research needs a bridge to be created amongst the previous work done in the same domain and the future scope referred from those work accomplished. It intertwines the work done and current scope of the research work. The knowledge gained from reading previous research articles and/or the books mentioned in an order to put forth the stream of thought that has flowed regarding the chosen topic. In fact, the topic of research was derived from the gap in research literature reviewed for various parameters like methods used for digital watermarking of an image, usage of various soft computing techniques in this process, energy consumption and energy efficiency techniques used in mobile phones and smart phones etc.
2.2. Steganography and Cryptography

Watermarking as a field of research and interest has been evolved from Steganography and it also associates its hiding algorithms with cryptography. Katzenbeisser & Petitcola [1] have provided their valuable research outcomes on information hiding techniques for steganography and digital watermarking, these have been used in various image watermarking research works. Diffie & Hellman [6] have provided new directions to the field of cryptography which is a great help in understanding the way of hiding the messages in any media. Badgaiyan and Dewagan [7] have provided their valuable research outcome on data hiding techniques in an image, which can be used in various mobile applications. Whereas, Chattopadhyay and Pal [8] have provided their valuable inputs through a Survey on Video Security with focus on H.264 Steganography, Cryptography and Watermarking techniques. Cox [5] have been the legendary researchers who have enlightened the path of image watermarking through secure spread spectrum watermarking for multimedia. Jawad and Gazali [9] have further enhanced the watermarking technique through a review of color image encryption techniques, which can be used in the current era of imaging. Samanta, Dutta, & Sanyal in [10] have provided the techniques of enhancement of security of RGB image using component wise permutation techniques.

2.3. Watermarking Schemes Adopted:

The watermarking schemes which operated directly on the original image in spatial domain were not providing a scenario of robust watermarking. In their
research work using frequency transformation of spatial domain to convert it into frequency domain and then insert the watermark was incorporated by Cox, Kilian, Leighton, & Shamoon in [5], where they not only described the method of creating strong and robust watermarks, but also revealed that there are two parts for building a strong watermark which are needed to be taken care; the watermark structure and the insertion strategy. In order for a watermark to be robust and secure, these two components must be designed correctly.

The above work was refereed by Agarwal & Mishra [16], they introduced A Novel Image Watermarking Technique using Fuzzy-BP Network for improvising the ways of research in this field of robust image watermarking. Agarwal, Mishra, & Sharma [17] have provided their collaborated efforts in the field of Digital image watermarking in DCT domain using fuzzy inference system and made the soft computing approach in this field as well established phenomenon. Furthermore, Agarwal C., Mishra, Sharma, & Chetty [18] elaborated and enhance their research work through the novel scene based robust video watermarking scheme in DWT domain using ELM which was rarely used in this domain of research prior to this work done. They also explained that the high speed of learning capacity showcased by ELM provided a positive variation in their research work.

Whereas, Liu & Tan [11] used the pseudo random noise sequences which were modified by the watermark using direct sequence spread spectrum techniques, Madhesiya & Ahmed in [12] involved both DCT and DWT as a transformation tool and SVD for optimization. Alattar [19] has worked on smart
images using DigiMarc watermarking technology and provided an altogether
new refined approach in this field of research.

Badgaiyan, Dewagan, Pandey, Yeulkar, & Sinha [7] have provided their
valuable research outcome on data hiding techniques in an image, which can be
used in various mobile applications. Chattopadhyay & Pal [8] have provided a
Novel, Low Complexity Video Watermarking Scheme for H.264 which is being
used in video transmission now a days. Chattopadhyay & Pal [2] have provided
their valuable inputs through a Survey on Video Security with focus on H.264
Steganography, Cryptography and Watermarking techniques.

Al-Gindy, Al-Ahmad, Qahwaji, & Tawfik [20] Watermarking of colour
images in the DCT domain using Y channel which became the baseline for their
research and helped in applying the watermarking through Y-channel in this
research work. Al-Gindy, Al-Ahmad, Qahwaji, & Tawfik [21] worked on a new
watermarking scheme for colour images captured by mobile phone cameras
which modernized the field of digital image watermarking.

Digital image watermarking through the usage of Singular Value
Decomposition [SVD] was done by Ali, Ahn, & Pant in [13] and Aslantas &
Mevlut [14], whereas videos watermarking using SVD have been explored by
Rajab, Al-Khatib, & Al-Haj [15] in their research paper. In his research work
Liu & Tan [11] explored the SVD based watermarking scheme for protecting
rightful ownership, whereas Madhesiya & Ahmed [12] explored advanced
technique of digital watermarking based on SVD-DWT-DCT and arnold
transform which altogether provided the robust framework for the technique of
digital watermarking.
Guo, Chen, Luo, & Chen [22] have worked on a blind watermarking algorithm using DWT and DCT techniques blended together for color image watermarking. Hess-Nielsen & Wickerhauser [23] have analyzed wavelets and related time frequency analysis, which is very helpful in the research work of this domain. Huang & Selin [24] have provided the research outcome as wavelet feature selection for image classification. Huang, Chiang, & Chang in [25] have described the robust spatial watermarking technique for color images via direct saturation adjustment which has opened new thoughts for its implementation in various upcoming applications. IDRISSI and others in [26] have synchronized two most important transformation techniques using their research about a Robust Digital Watermarking Technique using DWT-DCT and Statics blocks. Jawad & Gazali [9] have further enhanced the watermarking technique through a review of color image encryption techniques, which can be used in the current era of imaging. Jayant, Johnson, & Safranek [27] have worked on signal compression techniques through human perceptions which reduces the gap of applications developed from computer towards actual usage in real life. Jeedella & Al-Ahmad [28] have provided an algorithm for watermarking mobile phone colour images using BCH code which was used on static images already captured in the phone or downloaded from any social media. Jeswani & Sarode [29] have researched and provided an improved blind color image watermarking using DCT in RGB Color Space. Katzenbeisser & Petitcola [1] have provided their valuable research outcomes on information hiding techniques for steganography and digital watermarking, these have been used in various image watermarking research works.
Lee & Lu [30] has worked on FUZZY BP: a neural network model with fuzzy inference which incorporates soft computing techniques, this work helped during initial part of current research work. Lin & Lin [31] have devoted Wavelet based copyright protection scheme for digital images based on local features which is equally good research work for further usage in this domain. Lou, Ming-Chang, & Jhiang-Lung, [32] have not only worked for image watermarking but apply the same in Healthcare Image Watermarking Scheme Based on Human Visual Model and Back-Propagation Network. Nikoliadis & Pitas in [34] have worked for Benchmarking of watermarking algorithms which provides a comparative outcome amongst all well-known algorithms in this field. Park, Singhal, Lee, Cho, & Kim [35] have worked on Design and Performance Evaluation of Image processing algorithms on GPUs which will be used in forthcoming technology of designing GPUs for future computing and imaging machines.

Petitcolas [36] have provided Watermarking Schemes Evaluation which are used in all upcoming research work in this domain. Piao, Beack, Woo, & Han in [37] have described their research work through a blind watermarking algorithm based on HVS and RBF neural network for digital image. (Rao & Yip, 1990) have redirected the usage of Discrete Cosine Transform: Algorithms Advantages, Applications in various other research domains. Sewaif, Al-Mualla, & Al-Ahmad [38] has introduced 2 D Walsh Coding for Robust Digital Image Watermarking. Su, Yugang, Zou, & Zhao in [39] have worked on a blind double color image watermarking algorithm based on QR decomposition which opened a new perspective in this domain.
Verma, Jain, Agarwal, & Phadikar [40] have also introduced a new color image watermarking Scheme which could be further used in applications. Wang, Lin, & Yang in [41] defined an intelligent watermarking method based on particle swarm optimization which could be further used in optimization of such applications. Wei, Dai, & Li [42] have used Genetic watermarking based on DCT domain techniques which improvised the intelligence in such techniques. Wolfgang & Delp [43] have researched and provided a Fragile Watermarking using the VW2D watermark technique which is of immense utilization in Security and Watermarking of Multimedia Contents. Yong, Li-Cai, Shen, & Tao [44] provided a blind watermarking algorithm based on block DCT for dual colour images which has its own way of using block based transformations in this domain.

Zhao & Eckhard, [45] proposed and setup a new way of Embedding Robust Labels into Images for Copyright Protection. In their another work Zhao & Eckhard, [46] presented the work Towards robust and hidden image copyright labeling, which has defined the way of labeling text as a watermark in the digital images. Although, the work was still very helpful in understanding the labelling of watermark in the host image. Zhao, Hua, & Hu [47] have provided a blind watermarking algorithm based on DCT which is again of immense help in this research work. Zhou & Liu [48] have worked on Blind watermarking algorithm based on DCT for colour images.

Sharma, Prateek, & Chattopadhyay [3] have worked upon Optimized Robust Image Watermarking using HVS model supported by soft-computing and in the following research work [49] have used mix transformation
techniques and soft-computing through DCT Based Fuzzy Image Watermarking. Sharma, Prateek, & Chattopadhyay [4] have simulated the research outcome DCT and Simulink Based Real-time Robust Image Watermarking before going for the final mobile based application of image watermarking.


2.4. Energy Efficiency or Power Consumption in Mobile or Smart Phones

Miao, Yutao, & Jane [33] have applied in developing a mobile application known as hymnmark: Towards Efficient Digital Watermarking on Android Smartphones. Their work was of tremendous potential and provided the final guideline for this current research work towards measuring power consumed by the application using various parameters used in Android platform while executing any mobile app.

Watermarking of colour images in the DCT domain using Y channel which became the baseline for their research by Al-Gindy, Al-Ahmad, Qahwaji, & Tawfik [21]. In another paper by same authors [20] worked on a new watermarking scheme for colour images captured by mobile phone cameras which has revolutionized the field of watermarking, in their work have introduced a new watermarking scheme for colour images captured by mobile
phone cameras to provide security while being shared through Emails, SNS or MMS at that time. In this work an image authentication technique that embeds a binary watermark into a host color image was proposed, they have shared the process of Watermarking of colour images in the DCT domain using Y channel. An analysis of Power consumption in smartphones Carroll & Heiser [52] have provided a different dimension to the research where the applications running on mobile devices can have their energy usage graph in real time. New upcoming steganographic technique of hiding images in a mobile application was being explored by Badgaiyan, Dewagan, Pandey, Yeulkar, & Sinha, [7] and the energy consumption by various mobile apps were shared as their research work by Balasubramanian, & Venkataramani [53] have opened new ways of understanding the energy attributes of the mobile applications, whereas with the help of augmented smartphone application through the execution of clone cloud was shared by Byung-Gon & Petros [54] which has extended the work done in watermarking to be used in cloud activities as well. Carroll & Heiser [52] work on the Analysis of Power Consumption in a Smartphone and Self-constructive high-rate system energy modeling for battery-powered mobile systems was the outcome of Dong & Lin [55] has been a another milestone achieved in this direction of research.

Other schemes like Kejariwal, Gupta, Nicolau, Dutt, & Gupta [56], Energy Analysis of Multimedia Watermarking on Mobile Handheld Devices. The real time less energy consuming watermarking is exhibited by various researchers in past, Kejariwal, Gupta, Nicolau, Dutt, & Gupta [57] Energy efficient watermarking on mobile devices using proxy-based partitioning, performed the
energy efficient watermarking by using the “proxy based partitioning technique” for mobile devices, as digital image watermarking consumes computational resources exhaustively and adds to the drain of the battery power in handheld devices. It involves dual utilization of cyber infrastructure by utilizing the proxy server and the handheld device separately, which in turn leads to duplication of energy consumption. The proposed work exhibited the image authentication by reducing the cyber infrastructure load by utilizing the mobile devices in an energy efficient manner. Kshirsagar & Kulkarni [58] have worked on Real Time Implementation of Secured Multimedia Messaging Service System using Android as a mobile framework. While working with mobile telephony Lee, Yeh, & Chen [59] found the impact of inactivity timer on energy consumption on wcdma and cdma2000 technologies which revolutionized the mobile communication. Liu, Sridharan, Machiraju, Seshadri, & Zang [60] their work on Experiences in a 3g network: interplay between the wireless channel and Applications have also provided a thoughtful information in this context, which can be further used in upcoming wireless channels and there usage in application development. Mark Gordon [61] have provided a wonder app by the name of “PowerTutor” which has made the life easier regarding the application based research work especially on android. Motwani & Harris, Jr [62] have provided Fuzzy Perceptual Watermarking For Ownership Verification which defines a new way of softcomputing for multimedia validation especially images. Nikoliadis & Pitas [34] have worked for Benchmarking of watermarking algorithms which provides a comparative outcome amongst all well-known algorithms in this field. Pathak, Hu, & Zhang [63] have provided the answer to the important question of Where is the energy
spent inside my app? Fine Grained Energy Accounting on Smartphones with (Eprof Mobile Enerlytics).

Nurminen & Noyranen [64] has provided a research outcome on Energy-consumption in mobile peer-to-peer quantitative results from file sharing after an immense research work on this topic, which has been a very useful work for this research work. Rahmati & Zhong [65] have worked to find the answer in Context-for-wireless: context-sensitive energy-efficient wireless data transfer which is very important in current scenario. Xiao, Kalayanaraman, & Yla-Jaaski [66] have provided Energy consumption of mobile YouTube: Qualitative measurement and analysis which is again important in the context of energy measurement regarding mobile apps used. Yeh, Chen, & Lee [67] have provided the Comparative analysis of energy-saving techniques in 3gpp and 3gp2 systems which are directly associated in terms of image processing and executing as a compressed video.

2.5. Real Time/ Embedded Systems/ Computer Simulation and Mobile Application

Applications are built through coding techniques, and this research work used java as a language for application development, Dmitriev [68] work for Profiling Java applications using code hotswapping and dynamic call graph revelation has helped in understanding the technique for using dynamic perspective of java. But few of the techniques are executed in real time scenario using proxy based systems or Kim & Jung [69] embedded solutions like DSP
based or FPGA based; but none of them has proposed an energy efficient, software based real time digital image watermarking, which is the prime requisite for digital image authentication to a greater extent.

Chattopadhyay & Pal [8] A Novel, Low Complexity Video Watermarking Scheme for H.264 emphasized that in the field of computer vision there is a wide requirement of real-time digital image authentication, through some digital watermarking scheme. Based on the need analysis of Chattopadhyay & Pal [2] A Survey on Video Security with focus on H.264 Steganography, Cryptography and Watermarking techniques, the proposed work is planned to implement the robust digital watermarking in real time domain.

Mursalin, Fajrana, & Ridwanul [70] have implemented the real time digital image capturing and processing through microcontrollers for industrial purpose like fabric defect inspection system, using Microcontroller and Artificial Neural Network; this paper helped in understanding the real time implementation of capturing an image and applying some image processing technique over it. The work performed was restricted to the microcontrollers specifically for the detection of fabric. Our research work has implemented the real time robust digital watermarking through highly portable handheld mobile device.

Kim & Jung [69] has done the hardware implementation of the neural network controller using Micro Controller Unit (MCU) and Field Programmable Gate Array (FPGA) for nonlinear systems, which could help in understanding the way to implement neural network in a hardware configuration using MCU and FPGA. The limitation of the work performed was usage of two
separate components MCU and FPGA for hardware implementation of the neural networks, whereas our research work has utilized the microprocessors of the handheld mobile device itself.

Chattopadhyay & Pal [2] has done a survey and comparative analysis on various video watermarking techniques with reference to H.264/AVC and reciprocated that any image watermarking technique can be extended to video watermarking, but in reality video watermarking techniques face various other challenges than that in image watermarking schemes such as large volume of inherently redundant data between frames, real-time requirements in the video broadcasting etc. This paper presents the need for real-time image watermarking in the industry. In support of the work performed by T. Chattopadhyay the research work has implemented the semi-robust digital watermarking in real-time domain in energy efficient manner which is resource optimized.

The research work provides Universal approximation using incremental networks with random hidden computation nodes Huang, Chen, & Siew, [71] [72] [73] which has provided the information about randomization amongst hidden nodes that was applied in algorithm of this research work. They have provided their research outcome on Real-time learning capability of neural networks, which has enhanced the softcomputing part of the research. Mohanty & Elias [74] in their research outcome have worked on real-time perceptual watermarking architectures for video broadcasting, which is an advanced work towards real-time image processing and watermarking. Motwani & Harris, Jr. [62] have provided Fuzzy Perceptual Watermarking for Ownership Verification which defines a new way of softcomputing for multimedia validation especially
images. Nikoliadis & Pitas [34] have worked for Benchmarking of watermarking algorithms which provides a comparative outcome amongst all well-known algorithms in this field. Samanta, Dutta, & Sanyal [10] have provided the techniques of enhancement of security of RGB image using component wise permutation techniques. Satyanarayanan, et al., [75] have worked on Pervasive personal computing in an internet suspend/resume system which has provided the architecture for using pervasive personal computing in application of research work in mobile apps.

2.6. Usage of Soft computing (Fuzzy Logic/ Genetic Algorithm/ ANN) in the field of image watermarking

Agarwal & Mishra, [16] have proposed an image watermarking technique which has used the combination of Fuzzy logic and back propagation methods used in neural networks, it helped in understanding and using these techniques in my research work. Agarwal, Mishra, & Sharma [17] have proposed the techniques of using DCT as frequency transformation along with the fuzzy inference system as soft computing techniques for image watermarking. Agarwal C., Mishra, Sharma, & Chetty [18] in their research have proposed a novel scene based robust video watermarking scheme in DWT domain of frequency transformation using extreme learning machine as the fastest pattern learning mechanism. Chen & Huang, [76] in their research work have used co-evolutionary genetic watermarking technique for owner identification, which was quite good and workable in static images. Cormen, Leiserson, Rivest, & Stein, [77] in their book have emphasized upon various algorithm in different
fields of computer science. They were very helpful in implementation of the research work done so far. Digital image watermarking through the usage of Singular Value Decomposition [SVD] was done by Aslantas & Mevlut, [14], Freeman & Skapura, [78] Neural Networks Algorithms, Applications and Programming Techniques. Gupta, Jin, & Homma [79] have enlightened on Static and Dynamic Neural Networks and their usage in various applications. Huang, Zhu, & Siew [72] have provided their research outcome on Real-time learning capability of neural networks, which has enhanced the softcomputing part of the research.

Huang, Zhu, & Siew [73] Extreme learning machine: a new learning scheme of feedforward neural networks. Isac & Santhi [80] have done a study on digital image and video watermarking schemes using neural networks. Jang & Gulley [81] Fuzzy Logic Toolbox for Use With MATLAB has been an immense help in this research work. The real time less energy consuming watermarking is exhibited by various researchers in past, Kejariwal, Gupta, Nicolau, Dutt, & Gupta, [57] Energy efficient watermarking on mobile devices using proxy-based partitioning, performed the energy efficient watermarking by using the “proxy based partitioning technique” for mobile devices, as digital image watermarking consumes computational resources exhaustively and adds to the drain of the battery power in handheld devices. Other schemes like Kejariwal, Gupta, Nicolau, Dutt, & Gupta, [56], Energy Analysis of Multimedia Watermarking on Mobile Handheld Devices. Kim & Jung [69] has done the hardware implementation of the neural network controller using Micro Controller Unit (MCU) and Field Programmable Gate Array (FPGA) for
nonlinear systems, which could help in understanding the way to implement neural network in a hardware configuration using MCU and FPGA. Lee & Lu, [30] has worked on FUZZY BP: a neural network model with fuzzy inference which incorporates soft computing techniques. Lou & Yin [82] Adaptive Digital Watermarking using Fuzzy Logic Techniques which has been an important input for this research work. Madhesiya & Ahmed, [12] involved both DCT and DWT as a transformation tool and SVD for optimization. Mamdani & Assilian, [83] An experiment in linguistic synthesis with a fuzzy logic controller was the work gave a different dimension of using fuzzy logic controller in various other applications. Mehta, Rajpal, & Vishwakarma, [84] Adaptive Image Watermarking Scheme Using Fuzzy Entropy and GA-ELM Hybridization in DCT Domain for Copyright Protection, this research work was synthesized version of Fuzzy, ELM with transformation in DCT domain.

Mursalin, Fajrana, & Ridwanul, [70] have implemented the real time digital image capturing and processing through microcontrollers for industrial purpose like fabric defect inspection system, using Microcontroller and Artificial Neural Network; this paper helped in understanding the real time implementation of capturing an image and applying some image processing technique over it. The work performed was restricted to the microcontrollers specifically for the detection of fabric. Our research work has implemented the real time robust digital watermarking through highly portable handheld mobile device. Motwani & Harris, Jr. [62] have provided Fuzzy Perceptual Watermarking for Ownership Verification which defines a new way of softcomputing for multimedia validation especially images.

Nakamura, Katayama, Kitahara, & Nakazawa, [90] A fast and robust digital watermark detection scheme for cellular phones has been a help in understanding and implementing watermarking scheme in cellular phone. Nikoliadis & Pitas, [34] have worked for Benchmarking of watermarking algorithms which provides a comparative outcome amongst all well-known algorithms in this field. Park, Singhal, Lee, Cho, & Kim, [35] have worked on Design and Performance Evaluation of Image processing algorithms on GPUs which will be used in forthcoming technology of designing GPUs for future computing and imaging machines. Piao, Beack, Woo, & Han, [37] have described their research work through a blind watermarking algorithm based on HVS and RBF neural network for digital image. Ramamurthy & Varadarajan, [91] have provided their research outcome in the field of Robust Digital Image Watermarking Scheme with Neural Network and Fuzzy Logic Approach, which
has also provided the way of mapping two different soft computing techniques to achieve a problem.

Sharma, Prateek, & Chattopadhyay, [3] have worked upon Optimized Robust Image Watermarking and in the following research work Sharma, Prateek, & Chattopadhyay, GJEIS, [49] have used mix transformation techniques and soft computing through DCT Based Fuzzy Image Watermarking. Sharma, Prateek, & Chattopadhyay, IJIP [4] have simulated the research outcome DCT and Simulink Based Realtime Robust Image Watermarking before going for the final mobile based application of image watermarking. Sharma, Prateek, & Chattopadhyay, [92] in the work of Realtime Energy Efficient Digital Image Watermarking on Mobile Devices using Android which has provided an experimental outcome of DCT, DWT transformations mapped with ELM and executed as an app in android mobile framework. Shieh, Huang, Wang, & Pan, [93] in their research work Genetic watermarking based on transform-domain techniques has been a great help in understanding the usage of softcomputing in watermarking. Sun, Au, & Choi [94] proposed a neuro-fuzzy inference system through integration of fuzzy logic and extreme learning machines has been a great help in understanding the linking process of fuzzy logic and extreme learning machine frameworks. Szmidt & Kacprzyk, [95] have incorporated in their research work in finding Distances between intuitionistic fuzzy sets, which has been a help for this research to move ahead in the shape of an application. Tzafestas & Zikidis, [96] have worked on the topic of NeuroFAST: On-line neuro-fuzzy ART-based structure and parameter learning TSK model, which has been a help in
understanding neuro-fuzzy structure in learning process. Wang, Lin, & Yang, [41] have worked on an intelligent watermarking method based on particle swarm optimization, which is yet another technique in the field of designing optimal solutions. Wei, Dai, & Li, [42] have used the soft computing techniques with DCT transformation in the research work in Genetic watermarking based on DCT domain techniques. Zhang, Walter, Miao, & Lee, [97] in their research work of Wavelet Neural Networks for Function Learning has been a help for understanding the integration of wavelets with neural networks for any type of function learning.

Zadeh, [98] was a great inspiration while going through his work on Fuzzy sets, which actually transformed the way of implementing human perspectives in computer programming. Rajasekran & Vijaylakshmi Pai, [99] have written a book on Neural Networks, Fuzzy Logic, and Genetic Algorithms Synthesis and Applications, which has been a great source of learning in this field and its further usages in various research activities. Sivanandam, Sumathi, & Deepa, [100] written a book on Introduction to Neural Networks using MATLAB 6.0 which has been an immense help in applying neural networks in MATLAB environment and further used in a simulation environment of SIMULINK to understand the working in almost realtime framework. Tyagi, [101] written a book on Matlab and Simulink for Engineers which has opened up the doors of using MATLAB and SIMULINK for their usage in this research work.
2.7. ELM and its Applications

Huang, Zhu, & Siew, [73] in their research work have provided a powerful tool Extreme learning machine: a new learning scheme of feedforward neural networks, which has opened up plethora of opportunities in research and applications. Huang, Zhu, & Siew, [72] Extreme Learning Machine: Theory and Applications, has been a bunch of applications with a theory at the background for a better outcome in research. Sun, Au, & Choi, [94] A neuro-fuzzy inference system through integration of fuzzy logic and extreme learning machines. Huang G. B., [102] Extreme Learning Machines, website, has provided immense help to anyone who’d like to use this tool in research work.

Mishra A., Goel, Singh, Chetty, & Singh, [87] A novel image watermarking scheme using extreme learning machine, has been a research work of applying ELM in image watermarking for the first time. It changes the perception of using SLFN based ELM for the transformation of digital image watermarking in real time because of its least time consumption during the learning process. Agarwal C., Mishra, Sharma, & Chetty, [18] in their research have proposed a novel scene based robust video watermarking scheme in DWT domain of frequency transformation using extreme learning machine as the fastest pattern learning mechanism. Mishra & Goel, [88] A novel Image Watermarking Scheme using Hybrid DWT-DCT-ELM Technique, which integrated various tranformation techniques along with ELM and provided a hybrid scheme for faster computation. Mishra & Goel [89] A Novel HVS Based Gray Scale Image Watermarking Scheme Using Fast Fuzzy-ELM Hybrid Architecture.
Gao, Zhou, & Cui, [103] Reversible Watermarking Using Prediction-Error Expansion and Extreme Learning Machine, and Mehta, Rajpal, & Vishwakarma [84] Adaptive Image Watermarking Scheme Using Fuzzy Entropy and GA-ELM Hybridization in DCT Domain for Copyright Protection, this research work was synthesized version of Fuzzy, ELM with transformation in DCT domain. These research work have provided immense help in current research activity and design of scheme.

Sharma, Prateek, & Chattopadhyay [92] Realtime Energy Efficient Digital Image Watermarking on Mobile Devices using Android which has provided an experimental outcome of DCT, DWT transformations mapped with ELM and executed as an app in android mobile framework.

Cormen, Leiserson, Rivest & Stein [77] Introduction to Algorithms and Freeman & Skapura [78] Neural Networks Algorithms, Applications and Programming Techniques are some of the books published which are providing a well knotted theoretical approach to be used in application design or research work.

2.8. Applications of watermarking

Concept of Smart images using the technology of Digimarc was explored by Alattar [19] where he tried to bridge the gap of traditional and modern way of using images in electronic commerce and authenticate the same using digital watermark in physical or digital images. Al-Gindy, Al-Ahmad, Qahwaji, & Tawfik [21] worked on a new watermarking scheme for colour images captured
by mobile phone cameras which has revolutionized the field of watermarking. Al-Gindy, Al-Ahmad, Qahwaji, & Tawfik [20] in their work have introduced a new watermarking scheme for colour images captured by mobile phone cameras to provide security while being shared through Emails, SNS or MMS at that time. Digital image watermarking through the usage of Singular Value Decomposition [SVD] was done by Ali, Ahn & Pant [13]. Most of the help in developing this research work under execution phase has been provided by Android Open Source Project [104]. Badgaiyan, Dewagan, Pandey, Yeulkar & Sinha [7] have provided their valuable research outcome on data hiding techniques in an image, which can be used in various mobile applications. The energy consumption by various mobile apps were shared as their research work by Balasubramanian, Balasubramanian, & Venkataramani [53] have opened new ways of understanding the energy attributes of the mobile applications, whereas with the help of augmented smartphone application through the execution of clone cloud was shared by Byung-Gon & Petros [54] which has extended the work done in watermarking to be used in cloud activities as well. An analysis of Power consumption in smartphones Carroll & Heiser [52] have provided a different dimension to the research where the applications running on mobile devices can have their energy usage graph in real time. Chattopadhyay & Pal [8] A Novel, Low Complexity Video Watermarking Scheme for H.264 emphasized that in the field of computer vision there is a wide requirement of real-time digital image authentication, through some digital watermarking scheme. Elias, Mohanty & Pradhan [105] have provided their useful research outcomes on Simulink Based Architecture Prototyping of Compressed Domain MPEG-4 Watermarking. Ibrahim & Kee [106] have
provided an important research outcome in terms of MoBiSiS: An Android-based Application for Sending Stego Image through MMS, which has provided a logical framework of using android as a framework for the research work. Jeedella & Al-Ahmad [28] have provided an algorithm for watermarking mobile phone colour images using BCH code which was used on static images already captured in the phone or downloaded from any social media. The real time less energy consuming watermarking is exhibited by various researchers in past, Kejariwal, Gupta, Nicolau, Dutt, & Gupta [57] Energy efficient watermarking on mobile devices using proxy-based partitioning, performed the energy efficient watermarking by using the “proxy based partitioning technique” for mobile devices, as digital image watermarking consumes computational resources exhaustively and adds to the drain of the battery power in handheld devices. Other schemes like Kejariwal, Gupta, Nicolau, Dutt, & Gupta [56] Energy Analysis of Multimedia Watermarking on Mobile Handheld Devices. Kshirsagar & Kulkarni, March [58] have worked on Real Time Implementation of Secured Multimedia Messaging Service System using Android as a mobile framework. Lou, Ming-Chang, & Jhiang-Lung [32] have not only worked for image watermarking but apply the same in Healthcare Image Watermarking Scheme Based on Human Visual Model and Back-Propagation Network. Miao, Yutao, & Jane [33] have applied in developing an application known as hymnmark: Towards Efficient Digital Watermarking on Android Smartphones. Mark Gordon, [61] have provided a wonder app by the name of powertutor which has made the life easier regarding the application based research work especially on android. Nakamura, Katayama, Kitahara, & Nakazawa [90] a fast and robust digital watermark detection scheme for cellular phones has been a
help in understanding and implementing watermarking scheme in cellular phone. Nurminen & Noyranen [64] has provided a research outcome on Energy-consumption in mobile peer-to-peer - quantitative results from file sharing after an immense research work on this topic, which has been a very useful work for this research work. Park, Singhal, Lee, Cho, & Kim [35] have worked on Design and Performance Evaluation of Image processing algorithms on GPUs which will be used in forthcoming technology of designing GPUs for future computing and imaging machines. Rahmati & Zhong [65] have worked to find the answer in Context-for-wireless: context-sensitive energy-efficient wireless data transfer which is very important in current scenario. Satyanarayanan, et al. [75] have worked on Pervasive personal computing in an internet suspend/resume system which has provided the architecture for using pervasive personal computing in application of research work in mobile apps. Sharma, Prateek, & Chattopadhyay, [92] Realtime Energy Efficient Digital Image Watermarking on Mobile Devices using Android which has provided an experimental outcome of DCT, DWT transformations mapped with ELM and executed as an app in android mobile framework.