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Assimilation Result of Watermarking and Image Compression

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Abstract--- *In these days' digital international, trade of statistics is been held electronically. Therefore there arises the exceptional want for secure transmission of the concerned facts. Various practices like cryptography, watermarking, compression and so forth. Is common seeing that beyond few years? All these strategies were proved to be terrific of their respective paintings concerning protection. In this paper a brand new approach has been provided to provide safety at stronger stage. Here the two techniques specifically watermarking and compression are combined together to decorate the extent of security for statistics transmission motive. Here the watermarking the usage of DCT method is been combined with picture compression technique the usage of stepped forward adaptive Huffman encoding. The progressed adaptive Huffman coding approach is been based on Huffman set of rules. This new compression set of rules no longer most effective reduces the number of skip required to encode the records however at the same time reduces the garage area in comparison to adaptive Huffman and static Huffman respectively. The ultimate result Cozy records transmission*

Keywords--- *DCT Method, Cozy Records, Digital Watermarking, Image Compression, Improved Adaptive Huffman, Spatial Domain.*

I. INTRODUCTION

Watermarking is one of the most vital components related with facts hiding. It is a method that is been used to embed a few form of statistics inside visitor content: the visitor report can be a multimedia content inclusive of photograph, audio or video. It is essentially used for the purpose of copyright protection and owner authentication. Digital Watermarking technique receives its call from watermarking, which could be very common for the reason that past numerous years. Digital watermarking is a technique that provides strategy to the many longstanding troubles related with copyright of digital records that can be detected or extracted later to make out a few assertions about the information. This data may be textual statistics approximately the writer, its copyright, and so on; or it is able to be an photo itself. The record that desires to be hidden is embedded through manipulating the contents of the virtual statistics, permitting a person to identify the original owner, or inside the case of illicit duplication of bought fabric, the purchaser involved. These virtual watermarks continue to be inviolate beneath the conditions related with transmission/ transformation, allowing one to defend the possession rights in virtual shape. Digital watermarking has become a lively and essential region of studies, and improvement and commercialization ofwatermarking techniques is being deemed vital to assist address some of the demanding situations confronted by using the speedy proliferation of virtual content material. Digital watermarking got here to be in top notch demand when sharing data at the Internet have become a common practice. [1], [3]

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Classifications of Watermarking

1) Visible Watermarks

Visible watermarks are the ones watermarks which can be without difficulty perceived by way of the viewer, and truely discover the proprietor.

The seen watermarks are viewable to the ordinary eye together with bills, company logos and television channel trademarks and so forth. This kind of watermarks may be effortlessly viewed without the requirement of any mathematical calculation but on the equal time these embedded watermarks can be destroyed without problems. [3]

2) Invisible Watermarks

Invisible watermarks are the ones watermarks that cannot be perceived by using human eyes. This type of watermark isn't always seen in the watermarked image without degradation of photo or statistics. Invisible watermark may be any logo or any signature.

Most research presently focuses on invisible watermarks that are imperceptible beneath regular viewing conditions. [3]

Requirements of Watermarks

The fundamental requirements of virtual watermarking are:

1) Transparency: The watermark this is been embedded must no longer degrade the original picture nice. And in uncommon case if any distortions are seen within the photograph it tends to degrade the commercial fee of the photo [1]. 2) Robustness: Robustness is truly the perception of how a great deal can be carried out to the watermarked image within the form of assaults (deliberate and otherwise), such that the watermark can still efficiently be extracted from that altered photograph. In standard, an improved watermark is preferred to one that is much less so. [1] Capacity or Data Load: This amount describes the maximum amount of facts that may be embedded into the photograph to make certain accurate removal of watermark in the course of extraction. [1]

General watermarking system

The virtual watermarking device essentially consists of a watermark embedder and a watermark detector. The watermark embedder inserts a watermark onto the cover sign and the watermark detector detects the presence of watermark sign. An entity known as watermark key is used in the course of the method of embedding and detecting watermarks.

The watermark key has a one-to-one correspondence with watermark sign (i.e., a completely unique watermark key exists for every watermark signal).The watermark key is private and recognized to only authorized parties and it ensures that most effective legal events can discover the watermark. Further, the communication channel may be noisy and antagonistic (i.e., liable to safety assaults) and as a result the virtual watermarking strategies should be resilient to both noise and security assaults. [3]

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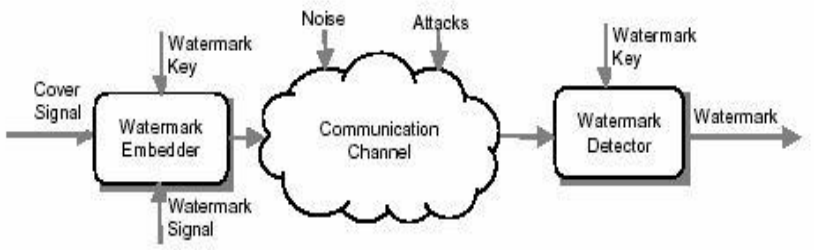

Fig.1: General water marking system

Techniques of digital watermarking

1) Spatial Domain Method

Spatial-domain method is been used for embedding the watermarks into a particular textual content, picture with the aid of at once changing the pixel values of authentic host photographs. Some commonplace spatial-domain algorithms encompass Least Significant Bit (LSB) Modification, Patchwork, Texture Block Coding, and so on. The maximum severe downside of spatial-area technologies is that it has a tendency to affords restricted robustness. It is complex for spatial-area watermarks to subsist below attacks inclusive of lossy compression and low-pass filtering. Also the amount of facts that may be embedded in spatial domain is likewise very confined. [5]

2) Frequency-Domain Technologies

In assessment to spatial-domain watermark, watermarks in frequency domain are extra robust and plenty greater compatible to popular photo compression requirements. Thus frequency-area watermarking technique is more widely used and obtains more attention in comparision to spatial area method. To embed a watermark, a frequency transformation needs to be carried out to the host data. Then, adjustments are made to the remodel coefficients. Possible frequency photograph alterations encompass the Discrete Fourier Transform (DFT), Discrete Cosine Transform (DCT) and others. In latest years they're turning into generally desolated. [5]

Application of watermarking

1) Copyright Protection

This is one of the most distinguished software of watermarks. Due to huge alternate of images over insecure networks, copyright protection becomes a very important difficulty. Watermarking an image will prevent its redistribution.

2) Authentication: In a few instances there arises the want to perceive the ownership of the contents. All this will be accomplished with the aid of embedding a watermark and supplying the owner with a private key that gives him an access to the message. ID playing cards, ATM cards, credit score playing cards are all examples of files that require authentication.

Broadcast Monitoring

From the call it's far clear that broadcast tracking is been used to verify the programs which might be broadcasted on TV or radio.

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It specifically allows the advertising corporations to peer if their classified ads appeared for the proper period or no longer.

4) Content Labeling

Watermarks can be used for presenting greater information about the cover object. This process is called content material labeling.

5) Tamper Detection

Fragile watermarks may be used to stumble on tampering in an image. If the fragile watermark is degraded in any way then we are able to say that the photo or record in query has been tampered.

6) Digital Fingerprinting

This is a procedure that is been used for detecting the proprietor of the content. This is so due to the fact every fingerprint is the unique traits of the owner.

7) Content safety

In this technique the content material stamped with a visible watermark this is very difficult to get rid of in order that it can be publicly and freely allotted. [1]

It is described because the discount of amount of statistics used to symbolize an image with the aid of lowering redundant records, in order that the image can be saved or transferred more successfully. Image compression is minimizing the size in bytes of a snap shots record without degrading the fine of the photo to an unacceptable stage. The discount in report length lets in extra photos to be stored in a given amount of disk or reminiscence area. It also reduces the time required for photos to be dispatched over the Internet or downloaded from Web pages. [9]Compression is accomplished through the elimination of one or extra of the three primary records redundancies:

Image compression

It is defined as the reduction of quantity of records used to represent a picture via decreasing redundant statistics, in order that the image can be saved or transferred greater correctly. Image compression is minimizing the scale in bytes of a images record without degrading the fine of the picture to an unacceptable degree. The discount in report length permits extra pics to be saved in a given quantity of disk or reminiscence space. It also reduces the time required for images to be sent over the Internet or downloaded from Web pages. [9]Compression is done by using the elimination of 1 or extra of the 3 simple facts redundancies:

1. Coding Redundancy
2. Interpixel Redundancy
3. Psychovisual Redundancy

Coding redundancy is present when less than ideal code words are used. Interpixel redundancy is due to correlations among the pixels of a picture. Psycho visual redundancy happens when the statistics is neglected by using the human visible machine (i.e. visually non important information). Image compression strategies lessen the wide variety of bits required to represent a photograph by using taking advantage of these redundancies. An inverse procedure known as decompression (decoding) is carried out to the compressed facts to get the reconstructed photo.

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The objective of compression is to lessen the number of bits as plenty as possible, at the same time as preserving the resolution and the visual nice of the reconstructed image as near the unique photo as viable[10]

Benefits of Compression

1) StorageSpace: Storage space, consisting of that provided by way of pc tough drives, comes at a rate. Compression of the statistics files allows saving extra documents in the storage area this is been to be had. Lossless compression, utilized in zip report era, will normally lessen a document to 50 percent of its authentic size. However, no difference is visible inside the document length if zip files are already in a compressed format, together with MP3 audio documents or PDF (Portable Document Format) text-only files [6].

2) Bandwidth and Transfer Speed The download technique uses community bandwidth each time we down load a document, which includes an MP3 audio record, from a server directly to the Internet. Bandwidth is the rate at which the community transfers statistics and is measured in terms of Mbps (megabits per 2d). Compressed files incorporate fewer "bits" of data than uncompressed files, and, as a consequence, use much less bandwidth while we download them. This approach that the switch velocity, that is to mention the time taken through the document to be downloaded is faster. It will take 10 seconds to download a file if we've got bandwidth of 1Mbps available, and we're downloading a record this is 10Mb (megabits) in size. It will handiest take 5 seconds to download the record if the document is compressed to 5Mb [6].

3) Cost The expenses of storing the large amount of statistics are decreased through compressing our documents for garage because through doing so we are able to shop more documents inside to be had garage area whilst they are compressed. We want to shop for a 2d 250MB force if we've 500MB (megabytes) of uncompressed information and a 250MB tough power on which to save it. We will now not need to buy the more hard drive if we compress the data documents to 50 percent in their uncompressed length. This saving may be applied to the charges of keeping an Internet connection. Many contracts with Internet Service Providers (ISP) consist of prices for the amount of statistics which you download. Download compressed documents, and by using doing so, one will be downloading a whole lot much less records than one might accomplish that while uncompressed files are been downloaded. The Internet download expenses can be less on account of this [6].

4) Accuracy It also reduces the risk of incidence of transmission errors due to the fact that fewer bits are transferred [10].

5) Security It additionally presents a level of security towards illegal monitoring [10].

Image compression techniques

The image compression techniques are extensively classified into two classes depending whether or now not a specific repro of the authentic photo can be reconstructed the use of the compressed photo.

These are:

1. Lossless method
2. Lossy approach
3. Lossless compression

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It is a compression approach that doesn't lose any records within the compression procedure. Lossless compression "packs statistics" right into a smaller file size with the aid of using a type of internal shorthand to suggest redundant information.

If a unique file is 1.5MB (megabytes), lossless compression can reduce it to approximately half of of that size, relying at the form of report this is being compressed. This makes lossless compression handy for transferring documents across the Internet, as smaller files switch faster. Lossless compression is also accessible for storing files as they soak up less room. The zip convention, utilized in applications like WinZip, makes use of lossless compression.

For this reason zip software program is popular for compressing program and data documents. That's because whilst those documents are decompressed, all bytes need to be gift to make sure their integrity.

If bytes are lacking from software, it might not run. If bytes are lacking from a facts document, it will be incomplete and falsified.

GIF image files additionally use lossless compression.

Lossless compression has benefits in addition to disadvantages. The gain is that the compressed document will decompress to a precise reproduction of the unique document, mirroring its exceptional. The downside is that the compression ratio is not all that excessive, exactly because no information is lost [7].

Following strategies are included in lossless compression:

1. Run period encoding
2. Huffman encoding
3. LZW coding
4. Area coding
5. Lossy Compression

It is a compression approach that doesn't decompress records back to a hundred% of the original. Lossy methods offer excessive levels of compression and result in very small compressed documents, but there is a positive amount of loss whilst they may be restored.

Audio, video and some imaging programs can tolerate loss, and in lots of cases, it could no longer be important to the human ear or eye.

In different cases, it may be important, however no longer that critical to the software. The greater tolerance for loss, the smaller the record may be compressed, and the quicker the report can be transmitted over a community. Examples of lossy report formats are MP3, AAC, MPEG and JPEG. Lossy compression is by no means used for commercial enterprise statistics and text, which demand a great "lossless" recovery. [8]

Lossy schemes generally tend to offer lots better compression ratios than lossless schemes. Lossy schemes are extensively used because the quality of the reconstructed pictures is adequate for maximum programs. By this scheme, the decompressed picture isn't identical to the authentic photo, however reasonably near it. [10]

Lossy compression strategies includes following schemes: 1. Transformation coding.2.Vector quantization 3.Fractal coding 4.Block Truncation Coding 5.Sub band coding

II. CONCLUSION AND FUTURE WORK

The expected output may be secured data transmission and the proposed system could be a secured monitoring system.

REFERENCES

[1] Tamilselvi, N., Krishnamoorthy, P., Dhamotharan, R., Arumugam, P., & Sagadevan, E. (2012). Analysis of total phenols, total tannins and screening of phytocomponents in Indigofera aspalathoides (Shivanar Vembu) Vahl EX DC. *Journal of Chemical and Pharmaceutical Research*, *4*(6), 3259-3262.

[2] Abraham, A.G., Manikandan, A., Manikandan, E., Jaganathan, S.K., Baykal, A., & Renganathan, P. (2017). Enhanced opto-magneto properties of Ni x Mg1–x Fe2O4 (0.0≤ x≤ 1.0) ferrites nano-catalysts. *Journal of Nanoelectronics and Optoelectronics*, *12*(12), 1326-1333.

[3] Barathiraja, C., Manikandan, A., Mohideen, A.U., Jayasree, S., & Antony, S.A. (2016). Magnetically recyclable spinel Mn x Ni 1− x Fe 2 O 4 (x=0.0–0.5) nano-photocatalysts: structural, morphological and opto-magnetic properties. *Journal of Superconductivity and Novel Magnetism*, *29*(2), 477-486.

[4] Kaviyarasu, K., Manikandan, E., Nuru, Z.Y., & Maaza, M. (2015). Investigation on the structural properties of CeO2 nanofibers via CTAB surfactant. *Materials Letters*, *160*, 61-63.

[5] Kaviyarasu, K., Manikandan, E., & Maaza, M. (2015). Synthesis of CdS flower-like hierarchical microspheres as electrode material for electrochemical performance. *Journal of Alloys and Compounds*, *648*, 559-563.

[6] Sachithanantham, P., Sankaran, S., & Elavenil, S. (2015). Experimental study on the effect of rise on shallow funicular concrete shells over square ground plan. *International Journal of Applied Engineering Research*, *10*(20), 41340-41345.

[7] Jayalakshmi, T., Krishnamoorthy, P., Ramesh Kumar, G., &Sivaman, I.P. (2011). Optimization of culture conditions for keratinase production in Streptomyces sp. JRS19 for chick feather wastes degradation, *Journal of Chemical and Pharmaceutical Research*, *3*(4), 498-503.

[8] Kumarave, A., & Rangarajan, K. (2013). Routing alogrithm over semi-regular tessellations. In *2013 IEEE Conference on Information & Communication Technologies*, 1180-1184.

[9] Sonia, M.M.L., Anand, S., Vinosel, V.M., Janifer, M.A., Pauline, S., & Manikandan, A. (2018). Effect of lattice strain on structure, morphology and magneto-dielectric properties of spinel NiGdxFe2− xO4 ferrite nano-crystallites synthesized by sol-gel route. *Journal of Magnetism and Magnetic Materials*, *466*, 238-251.

[10] Rebecca, L.J., Susithra, G., Sharmila, S., & Das, M.P. (2013). Isolation and screening of chitinase producing Serratia marcescens from soil. *Journal of Chemical and Pharmaceutical Research*, *5*(2), 192-195.

[11] Banumathi, B., Vaseeharan, B., Rajasekar, P., Prabhu, N.M., Ramasamy, P., Murugan, K., & Benelli, G. (2017). Exploitation of chemical, herbal and nanoformulated acaricides to control the cattle tick, Rhipicephalus (Boophilus) microplus–a review. *Veterinary parasitology*, *244*, 102-110.

[12] Gopinath, S., Sundararaj, M., Elangovan, S., & Rathakrishnan, E. (2015). Mixing characteristics of elliptical and rectangular subsonic jets with swirling co-flow. *International Journal of Turbo & Jet-Engines*, *32*(1), 73-83.

[13] Thooyamani, K.P., Khanaa, V., & Udayakumar, R. (2014). Efficiently measuring denial of service attacks using appropriate metrics. *Middle - East Journal of Scientific Research*, *20*(12): 2464-2470.

[14] Padmapriya, G., Manikandan, A., Krishnasamy, V., Jaganathan, S.K., & Antony, S.A. (2016). Enhanced Catalytic Activity and Magnetic Properties of Spinel MnxZn1−xFe2O4 ($0.0 \leq x \leq 1.0$) Nano-Photocatalysts by Microwave Irradiation Route. *Journal of Superconductivity and Novel Magnetism*, *29*(8): 2141-2149.

[15] Rajesh, E., Sankari, L.S., Malathi, L., & Krupaa, J.R. (2015). Naturally occurring products in cancer therapy. *Journal of pharmacy & bioallied sciences*, *7*(1), S181-S183.

[16] Vanangamudi, S., Prabhakar, S., Thamotharan, C., & Anbazhagan, R. (2014). Dual fuel hybrid bike. *Middle-East Journal of Scientific Research*, *20*(12): 1819-1822.

[17] Brindha, G., Krishnakumar, T., & Vijayalatha, S. (2015). Emerging trends in tele-medicine in rural healthcare. *International Journal of Pharmacy and Technology*, *7*(2): 8986-8991.

[18] Sharmila, S., Rebecca, L.J., Chandran, P.N., Kowsalya, E., Dutta, H., Ray, S., & Kripanand, N.R. (2015). Extraction of biofuel from seaweed and analyse its engine performance. *International Journal of Pharmacy and Technology*, *7*(2), 8870-8875.

[19] Thooyamani, K.P., Khanaa, V., & Udayakumar, R. (2014). Using integrated circuits with low power multi bit flip-flops in different approch. *Middle-East Journal of Scientific Research*, *20*(12): 2586-2593.

[20] Thooyamani, K.P., Khanaa, V., & Udayakumar, R. (2014). Virtual instrumentation based process of agriculture by automation. *Middle-East Journal of Scientific Research*, *20*(12): 2604-2612.

[21] Udayakumar, R., Kaliyamurthie, K.P., & Khanaa, T.K. (2014). Data mining a boon: Predictive system for university topper women in academia. *World Applied Sciences Journal*, *29*(14): 86-90.

[22] Anbuselvi, S., Rebecca, L.J., Kumar, M.S., & Senthilvelan, T. (2012). GC-MS study of phytochemicals in black gram using two different organic manures. *J Chem Pharm Res*., *4*, 1246-1250.

[23] Subramanian, A.P., Jaganathan, S.K., Manikandan, A., Pandiaraj, K.N., Gomathi, N., & Supriyanto, E. (2016). Recent trends in nano-based drug delivery systems for efficient delivery of phytochemicals in chemotherapy. *RSC Advances*, *6*(54), 48294-48314.

[24] Thooyamani, K.P., Khanaa, V., & Udayakumar, R. (2014). Partial encryption and partial inference control based disclosure in effective cost cloud. *Middle-East Journal of Scientific Research*, *20*(12): 2456-2459.

[25] Lingeswaran, K., Prasad Karamcheti, S.S., Gopikrishnan, M., & Ramu, G. (2014). Preparation and characterization of chemical bath deposited cds thin film for solar cell. *Middle-East Journal of Scientific Research*, *20*(7), 812-814.

[26] Maruthamani, D., Vadivel, S., Kumaravel, M., Saravanakumar, B., Paul, B., Dhar, S.S., & Ramadoss, G. (2017). Fine cutting edge shaped Bi2O3rods/reduced graphene oxide (RGO) composite for supercapacitor and visible-light photocatalytic applications. *Journal of colloid and interface science*, *498*, 449-459.

[27] Gopalakrishnan, K., SundeepAanand, J., & Udayakumar, R. (2014). Electrical properties of doped azopolyester. *Middle-East Journal of Scientific Research*, *20*(11), 1402-1412.

[28] Subhashree, A.R., Parameaswari, P.J., Shanthi, B., Revathy, C., & Parijatham, B.O. (2012). The reference intervals for the haematological parameters in healthy adult population of chennai, southern India. *Journal of Clinical and Diagnostic Research: JCDR*, *6*(10), 1675-1680.

[29] Niranjan, U., Subramanyam, R.B.V., & Khanaa, V. (2010). Developing a web recommendation system based on closed sequential patterns. *International Conference on Advances in Information and Communication Technologies*, 171-179.

[30] Arunanand, M., Paranthaman, S., & Deepa, K. (2017). Tele Monitoring of Chronic Heart Patient in Real-Time Using a Wearable Sensors and Smart Phone. *Excel International Journal of Technology, Engineering and Management, 4*(1), 10-13.

[31] Sabarirajan, K.M., Sudarsanan, P., Srinithi, V., Thirumalsundar, V., & Senthil, T. (2017). Household Computerization with Internet of Things (IOT). *Excel International Journal of Technology, Engineering and Management, 4*(1), 20-22.

[32] Parameshwaran, R. (2017). Design of Low Power Based Efficient Multiplier for Signal Processing Applications. *Excel International Journal of Technology, Engineering and Management, 4*(1), 30-33.

[33] AnanthHari, R. (2017). Comparison of Various Scan-Chain Free Functional Testing for Secured Hardware Systems. *Excel International Journal of Technology, Engineering and Management, 4*(1), 34-37.

[34] Bamber, & Jason, M. (2017). News Filtering and Summarization System Architecture for Recognition and Summarization of News Pages. *Bonfring International Journal of Data Mining, 7*(2), 11-15.

[35] Ziarani, R.J., Abadi, P.M., & Madadi, M.A. (2016). Image Processing With GDS Matrix. *International Academic Journal of Innovative Research, 3*(1), 32-35.

[36] Kooshki, S.A., Zeinabadi, H., Jafarnezhad, A., & kooshki, H.A. (2016). Applications of Fuzzy Logic and Artificial Neural Networks in Evaluation and Ranking of Teachers Based on "Framework for Teaching" Model. *International Academic Journal of Innovative Research, 3*(2), 1-10.

[37] Katiyar, H. (2014). Optimal Power Allocation for Regenerative Relay over Î±-µ Fading Channel. *International Journal of Communication and Computer Technologies, 2*(2), 128-134.

[38] Gupta, V., Sharma, P., & Gill, H. (2014). Wireless Data Routing with Security Keys. *International Journal of Communication and Computer Technologies, 2*(2), 135-138.

[39] Dhanalakshmi, N., Atchaya, S., & Veeramani, R. (2015). A Design of Multiband Antenna Using Main Radiator and Additional Sub-Patches for Different Wireless Communication Systems. *International Journal of Communication and Computer Technologies, 3*(1), 1-5.

[40] Slimani, Y., Baykal, A., & Manikandan, A. (2018). Effect of Cr3+ substitution on AC susceptibility of Ba hexaferrite nanoparticles. *Journal of Magnetism and Magnetic Materials, 458*, 204-212.

[41] Premkumar, S., Ramu, G., Gunasekaran, S., & Baskar, D. (2014). Solar industrial process heating associated with thermal energy storage for feed water heating. *Middle East Journal of Scientific Research, 20*(11), 1686-1688.

[42] Kumar, S.S., Karrunakaran, C.M., Rao, M.R.K., & Balasubramanian, M.P. (2011). Inhibitory effects of Indigofera aspalathoides on 20-methylcholanthrene-induced chemical carcinogenesis in rats. *Journal of carcinogenesis, 10*, 2011.

[43] Beula Devamalar, P.M., Thulasi Bai, V., & Srivatsa, S.K. (2009). Design and architecture of real time web-centric tele health diabetes diagnosis expert system. *International Journal of Medical Engineering and Informatics, 1*(3), 307-317.

[44] Ravichandran, A.T., Srinivas, J., Karthick, R., Manikandan, A., & Baykal, A. (2018). Facile combustion synthesis, structural, morphological, optical and antibacterial studies of Bi1− xAlxFeO3 (0.0≤ x≤ 0.15) nanoparticles. *Ceramics International, 44*(11), 13247-13252.

[45] Thovhogi, N., Park, E., Manikandan, E., Maaza, M., & Gurib-Fakim, A. (2016). Physical properties of CdO nanoparticles synthesized by green chemistry via Hibiscus Sabdariffa flower extract. *Journal of Alloys and Compounds, 655*, 314-320.

[46] Thooyamani, K.P., Khanaa, V., & Udayakumar, R. (2014). Wide area wireless networks-IETF. *Middle-East Journal of Scientific Research, 20*(12), 2042-2046.

[47] Sundar Raj, M., Saravanan, T., & Srinivasan, V. (1785). Design of silicon-carbide based cascaded multilevel inverter. *Middle-East Journal of Scientific Research, 20*(12), 1785-1791.

[48] Achudhan, M., & Prem Jayakumar, M. (2014). Mathematical modeling and control of an electrically-heated catalyst. *International Journal of Applied Engineering Research*, *9*(23).

[49] Thooyamani, K.P., Khanaa, V., & Udayakumar, R. (2013). Application of pattern recognition for farsi license plate recognition. *Middle-East Journal of Scientific Research*, *18*(12), 1768-1774, 2013.

[50] Jebaraj, S., & Iniyan S. (2006). Renewable energy programmes in India. *International Journal of Global Energy*, 26: 232-257.

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