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CLOUD COMPUTING BASED IMAGE PROCESSING FOR SECURE DATA TRANSMISSION

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Abstract:
The technology of image processing provides a practical solution to the many issues related to the processing of the signal's information. The objective of this paper is to analyze the cloud computation based image processing algorithms and its design. This paper also presents cloud computation methods for processing of information in the image with a specified protocol for the data transmission. In these methods, a technique based on structure of materials and their performance is selected as an algorithm for verification. In addition, the algorithm begins with the extraction of features from the image rather than preprocessing of image, which common in traditional method of image processing. Thus based on this, a structure of processing an image in real time system using standard database and initial filtering application are used for the functional analysis. The privacy of data in the image processing and the security is enhanced by the use of cloud computation and is revealed by the literature survey. The proposed algorithm for the image processing has many advantages in exchanging the data between the sender or transmitter and the receiver using the technique among the wireless sensor network nodes.

Introduction:

Every day we go through many images from the different sources. These images are now the source of data or the information. From the image a huge amount of data is received when we carefully observe the image. Cryptography will come into picture when we want to transfer confidential images in a safe and secured manner. Encryption of images and videos has various applications in different areas such as communication in the military fields, communication using the internet, telemedicines, systems that uses multimedia, and in the field of medical images. With the advancement in the development of network and multimedia technologies, several colour images are stored and transmitted by using the wireless network and the internet. From the period of Shannon's (1949) to till today cryptography is playing a crucial part in the area of security, which is work field of many scientists and the mathematicians. There are many algorithms for the cryptography (encryption and decryption) were developed, namely IDEA, AES, RSA, DES and several others. The method of cryptography deployed in this paper is ECC – Elliptic Curve Cryptography, as the literature survey on the ECC tells that solving the problem of elliptic-curve discrete-logarithm will become difficult in an exponential manner in proportion with the size of the key. Thus, ECC is better suited for the process of encryption and decryption in comparison with the other methods of cryptography. The ECC was introduced by two persons independently, namely Victor S Miller and Neal Koblitz in 1985, that uses the public key. The ECC obtained popularity and acceptance in and around the year 2004.

1. Literature Review:

The authors of [1] discussed the various problems related to the arithmetic ECs - Elliptic Curves along with the details of protocols for implementing. Next, the authors of [2] gave the mathematical proof for the theories of EC and the authors of [3] discussed the several implementing issues of ECC. For the transmission of image in a safe and secured manner, many methods were designed and implemented in the recent period. The authors [4] proposed an encryption method for image by using chaotic system with the CEC – Cyclic Elliptic Curve. In this method, a stream of pseudo-random key will be produce by the use of CEC and this key is used for encrypting the image information stream.

Using the hybrid concept of EC and chaotic systems the authors of [5] proposed an encrypting method for the image based on cryptanalysis. The authors concluded an encrypted image can be generated by the use of a plain image attacked by the plain text of known type, with all pixel values equal to zero. A method of encrypting an image based on the ECC was presented by the authors of [6]. In this method, the authors used a generator of type coupled linear-congruential for producing a random k integer and a private key. Point-to-point multiplication for each value pixel is performed to fit over the EC coordinate for obtaining the ciphered image. For decryption process, mapping table is used. An encryption method based on EC over the Prime Group field was presented by the authors of [7]. The authors generated a mapping table that contains values from 0 to 255 in the row, which contains the EC coordinates for which every pixel values of mapped and the encryption was performed by the use of receiver's public key. To view the ciphered image, data which is encrypted is mapped using the table back with the values from 0 to 255.

The authors of [8] presented a new encrypting method for images by using the Jacobian elliptic maps. Here, the authors perform transformation of image matrix to 1-D matrix by operating with the key generated based on initial conditions and the controlling parameters. Next, the matrix elements were encrypted and it is reverse transformed to the original dimensions.

An encryption technique based on homomorphic images with EC elgamal was proposed by the authors of [9] to transfer the confidential images. The authors chose the characteristics of the EC to avoid the Pohlig Hellman, isomorphic and Pollard's rho attacks. The outcome of the experiment shows that the proposed method performs better when compared to RSA. The authors of [10] explained the method of implementing EC algorithm for the digital signature along with the problems encountered related with interoperability and security.

The authors of [11] proposed two method of encrypting the image using the ECC. First method is used for the coefficients of DCT, which are selectively quantized. The second method of encryption is for the bit plane. The authors of [12] selected parameters in the EC domain for the finite-prime fields.

Different downs and ups of ECC and the acceptance of people by time were explained by the authors of [13] along with the technologies required for the social constructions. The authors of [14] gave the idea for different methods of cryptography and security to the network. The authors of [15] provided different parameters of the ECC of varying bit size for the ECC brain-pool and the NIST – National Institutes of Standards and Technology data. The images used in this experiments are taken from the USC SIPI – University of Southern California Signal and Image Processing Institute [17].

2. Problem Statement:

In the domain of image processing secure data transmission over the communication channel is very tedious and important as well. As per the general saying that the image can speak more than the chunk of text over the scenario. Distribution of the same image over the wide wireless sensor network in an ideal manner is crucial for a communication using different protocols. In the secure communication it can treated that key exchange and encryption and decryption should be fast enough and robust to the system.

3. Proposed Methodology:

Block diagram of proposed method of cryptography using ECC is shown in the Figure-1. In the proposed methodology, the input image (lena image) is taken and preprocessed using different image filtering techniques such as Median filter and average filter.

Block Diagram of the proposed system:

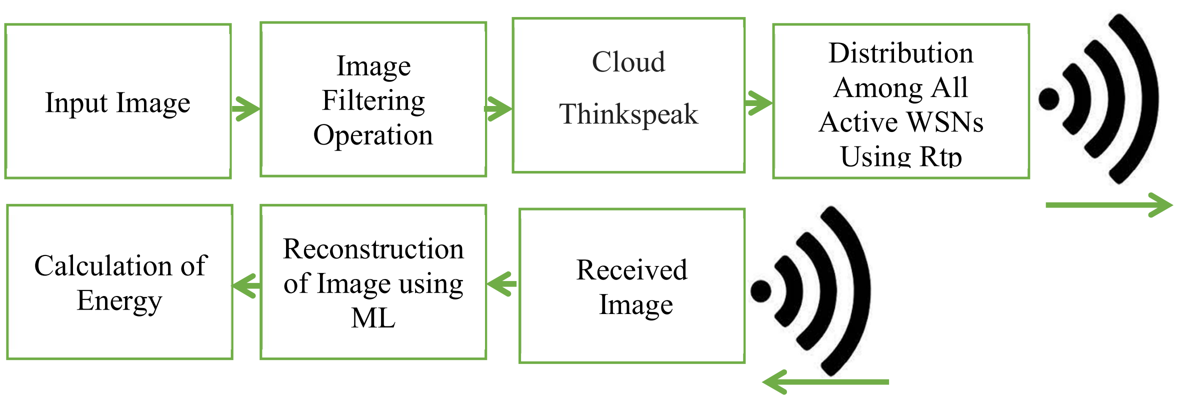


Figure-1: Proposed Block Diagram

Image Filtering Operation:

Before processing the image, images has to be undergo with the filtering operations for eliminating the noises. Various types of filters are available in literature for removing the noises in images. Here we considered two different filters for analyzing the performance in removing the different noises in input (lena) images. In the filtering technique, the three primary components of the image (R, G and B) are separated by using appropriate filters which are built-in the Matlab tool. After this, gain amplification is carried out to reduce the effect of attenuation, which occurs due to the filtering. Then, appropriate filter (Median Filter and

Average Filter) is applied to eliminate the noises in image. The filtered primary components are then combined to form the coloured image.

Median Filter:
Median filter is also known as edge preserving filter and it is a nonlinear method of denoising process. It proceeds in a way that every pixel is reacquired by the median value of neighboring pixels. It proves to preserve the edges and lines of an image in best possible way and removes the outliers. The mathematical expression for the median filter is given in the equation (1),

Z(m, n) = Median of {y(i, y), (i, y)∈ W} ------(1)

where W is the neighborhood of location (i, y) in the image.

Median filter Algorithm

Step-1:- Choose 2-D window W of the size 3x3. Let $P_{x,y}$ is the pixel to be processed.

Step-2:- Find the median W_{med} of the pixel values in W.

Step-3:- Substitute $P_{x,y}$ by median W_{med}.

Step-4:- Repeat the Steps-1 to Step-3 for all pixels in the complete image.

An example of the median algorithm is shown in the Figure-2. Here, the size of the window is 3x3 and consists of the elements 10, 5, 20, 14, 80, 11, 8, 3, 22. The median filter computes the median of these elements by arranging these elements in an ascending order, then selects the middle element. Center element value will be replaced with this median value and the process is repeated by sliding the window one pixel element and the entire image will be computed.

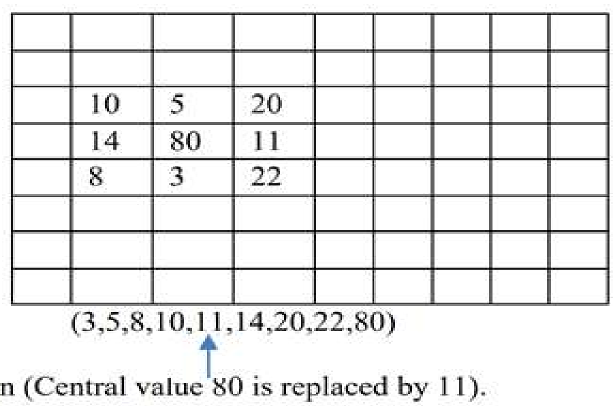


Figure-2: Example of Median filter

Average (Mean) Filter

Mean filtering is a process of smoothing images by compressing the extent of intensity variations among the neighboring pixels. This filter proceeds in a way that every pixel is replaced by the mean of neighboring pixel including itself.

$$Y\widehat{(m,n)} = \frac{1}{M \times N} \sum_{(i,j) \in W} x(i,j) \text{ -------(2)}$$

In this equation, w is neighborhood that is focused on (m, n) of the image, MxN is window size and x(i, j) is the pixel intensity value.

Cloud Thinkspeak

ThingSpeak is a platform for the IoT analytic services which gives services such as live streaming of the data and performing operations on that in real time. Some of the operations that can be performed on the live data stream are visualization, aggregation and analysis. The information is transferred to the Thingspeak from end users for creating instantaneous live data visualization and to send the alerts. It has the feature that can run the Matlab codes to process and analyze the data in real time. Thingspeak can be used to create prototypes, as the proof of IoT system concepts which require the analytics. The data can be directly transferred to the Thingspeak from any device which is connected to the internet with the application of MQTT or Rest API. Moreover, it possible to have the integration between clouds with the Senet, ThingsNetwork and Libelium-Meshlium gateways. Input-Output particle enables data of the sensor to get transmitted to Thingspeak using the wireless medium with 3G / 4G cellular networks or LoRa WAN connection. By using the Thingspeak, we can perform data analysis, storing the data in cloud without programming the Web-servers. It is also possible to make sophisticated alerting E-mails, which are triggered depending on the incoming data from the devices that are connected.

WSN

WSN - Wireless Sensor Network is defined as the wireless network which doesn't have any infrastructure and will be implemented in an ad-hoc network using huge number of wireless-sensors. The WSN are used for monitoring the conditions of the environment or any other physical conditions. The wireless sensor nodes in the WSN consist of a built-in processor, which monitors and manages the specific geographical area's environment. These nodes will be connected to BS – Base Station, which is the processing unit for the WSN systems. Again BS is directly connected to the internet for sharing the information. The WSN has the following components:

i. **Sensors**: These are used for capturing the values of the environmental parameters, i.e., for acquisition of the data. The sensed signals are transformed to the signals of electrical type.
ii. **Radio Nodes**: These are utilized for receiving the information generated by sensors and transfer it to WLAN Accessing Point. They contain a transceiver, controller (usually microcontroller), memory and the source of power.
iii. **WLAN Access Points**: These points perform the reception of the information sent from radio nodes in a wireless medium through internet.
iv. **Evaluation Software**: It is the software used to process the data or information received by WLAN Access Point and it sends report to the end users for necessary actions/further processing.

Advancement in the technologies in the area of MEMS – Micro Electro Mechanical Systems made the production of small scale, low cost, less power consuming sensors. These sensors are capable of performing operations like processing the data, storing and transmitting/communicating it to other devices. These sensors are implemented in a huge number over the large physical area to create WSN. These WSNs are used to control and monitor the real time situations, and is shown in the Figure-3. A WSN contains a huge number of small sized low cost sensors implemented in the geographical area for monitoring environment parameters. These networks constructs a self organizing multihop flexible network using the wireless communications such that each sensor node location can be relocated at any point of time and also they can be connected to the internet by using wireless medium or wired medium. The goal of this network methodology is to collectively perform the operations like sensing, collecting and processing the information from the sensors to the observer. The basic three components of the WSN are observers, sensed-objects and sensors. Quantitative collection of data, aggregation of the data and data processing plays major role in the faster enhancement, which is the result of implementing nodes densely. WSN is current research field which involves the intersection of multi-disciplines and gives reliable applications.

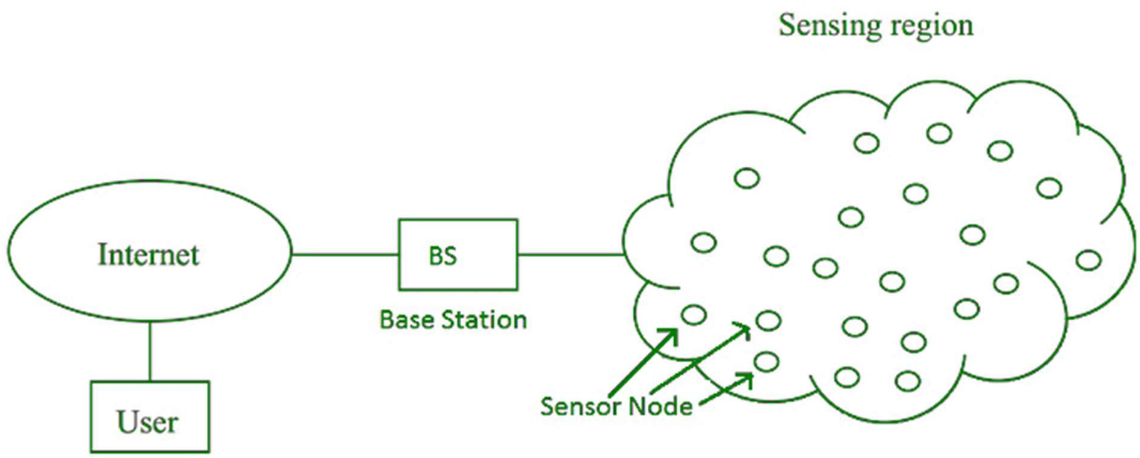


Figure-3: Deployment of WSN

A device that reacts to the physical parameters like temperature, pressure and converts to electrical quantity is called sensor. The sensor automatically performs processing and interpretation jobs. Again, sensor node is a compact autonomous device which consists of sensors and other parts for processing sensed data. Therefore, node produces data by sensing the physical parameters and transfers to the main place. Thus sensor node consists of a controller, sensor, power source, memory and a communication device. Based on the necessity of applications other devices like locomotary, GPS, etc can be added.

RTP Protocol

RTP - Real Time Protocol is a protocol that is used to manage the real time traffics such as video and audio, of the internet. It should be used along with the UDP. It is not having port numbers or any type of delivery techniques. It supports various file formats such as MJPEG and MPEG. RTP is highly sensitive to the delay produced by the packet and somewhat less sensitive to the loss of the packet. Its format is shown in the Figure-4. RTP header will have a simple format and it can be used for all the applications of real time. The header format fields are as given below:

- **Version**: It is a two bit field and it indicates the version number. Present version is 2.
- **P –** It is a one bit field. If it is 1, then it indicates that padding is present else if it is 0, it indicates absence of padding. Padding is done at the end of each packet.
- **X –** It is a one bit field. If it is 1, then it indicates header extra extension is present else if it is 0, it indicates absence of header extra extension. Extra extension of the header is done in between the data and the basic header.
- **Contributor count –** It is a four bit field and indicates the number of the contributors. Maximum is 15 contributors, as for four bit 0 to 15 only possible.
- **M –** It is a one bit field and is used to indicate the end of data or as end marker.
- **Payload types –** It is a seven bit field and is used to indicate the payload type.
- **Sequence Number –** It is a sixteen bit field and is used to provide serial number to the packets of RTP. This helps in sequencing of the packets and to handle the situations where loss of the packets occurs. The starting number is selected is a random number, but for each packet this number gets incremented by one.
- **Time Stamp –** It is a thirty two bit field and is utilized to obtain relation between the various RTP packet timings. For the first RTP packet, a random value is selected and next packets it is the addition of previous time-stamp value and the time required to generate the first byte in the present packet. The one clock tick or time value differs from one application to the other application.
- **Synchronization Source Identifier –** It is a thirty two bit field and is used to recognize the source and to define source. The value of this field is taken by the source itself, which is a random number. It is useful in resolving the time conflicts between the two sources.
- **Contributor Identifier –** It is a thirty two bit field and is used to identify the source when there are two or more sources are available in the session. Mixer source uses the source synchronization identifier field and the rest of sources, at the maximum of 15, utilizes the contributor identifier field.

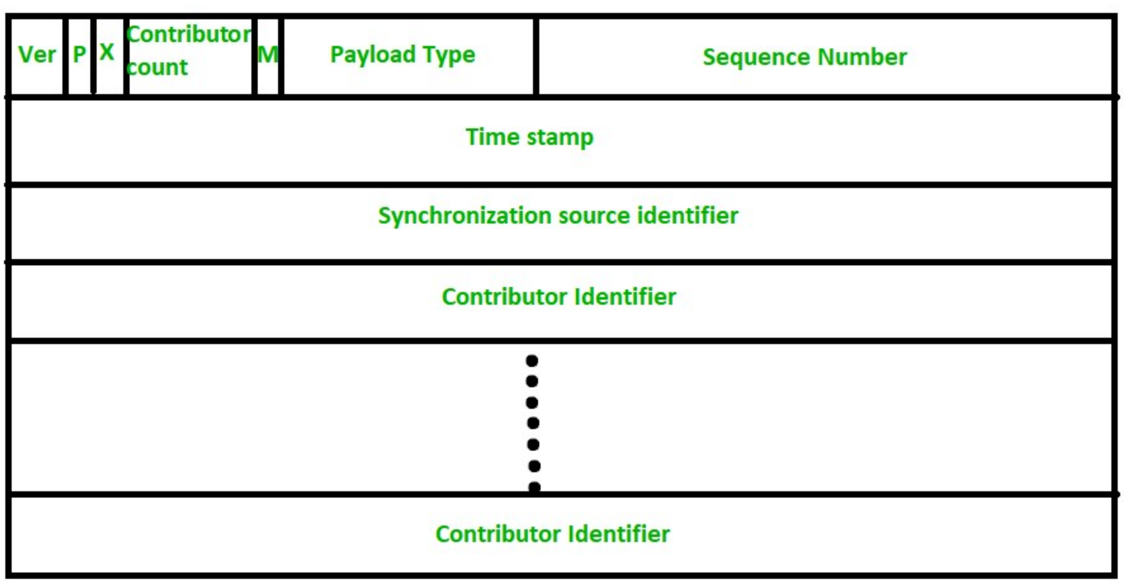


Figure-4: Header format of RTP packet

Reconstruction of Image using Machine Learning

PET techniques based on the deep learning use the mapping of raw data to the images that are under the diagnostic. The neural network can be given training for mapping the raw information directly to the required output image, in an end to end way which provides an alternate method as compared to the traditional techniques of reconstructing the image. On the other hand, the presently existing techniques of iterative approaches can made modifications so that neural network concepts can be introduced while maintaining the consistency of data. Figure-2 gives the comparison of the various approaches of reconstructing images based on the deep learning.

End – to – end

PET reconstructing techniques (Figure-2.a) based on deep-learning end to end way make an effort to directly map the data of sinogram to respective image data space by using neural networks. The parameters of the N network are given training to map S - sinogram data to their respective distribution of positron annihilation. Alternatively, iterative reconstructing methods demand a model which forward the process accurately and the deep-learning end to end techniques can be used as similar to that of the analytical reconstructing techniques like FBP – Filtered Back Projection for completely characterize the reverse process with one single step without the used separate explicit model for the forward processes.

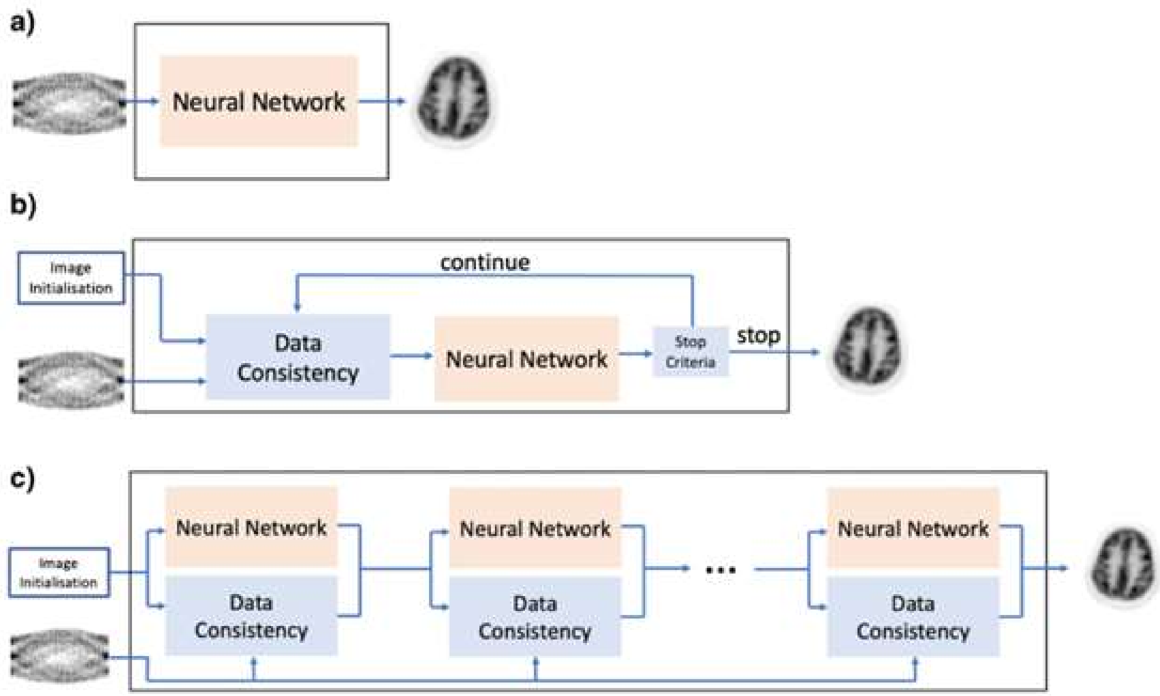


Figure-2: Comparison of the various approaches of deep learning for reconstructing image

These techniques will have data driven feature which gives a means to overcome the potential errors and the constraints of the well-defined model; however the useful data or information provided by it will be discarded, to achieve this. To perform domain transformation many research works used full convolutional neural networks. The methods that use completely connected layer of transform domain will have architecture of network which is described by configuration of the 3 modules namely, module of sinogram processing given as $z_s = S(s ; \Theta s)$, learned module which transform from space of sinogram to the space of image, 휇 $= I(zd;\Theta I)$, and the third one is module for image processing. The authors of [45] proposed a mapping of end to end PET sonograms to the Deep PET images by the use of modified Unet-trained over digital-phantom data on the XCAT synthetic platform. SSIM – Structural Similarity Index, PSNR – Peak Signal to Noise Ratio, RMSE – Root Mean Squared Error have beaten the OSEM – Ordered Subset Expectation Maximization and FBP reconstructions for the data with synthetic evaluation by giving a solid conceptual proof. The authors of [46] reconstructed and included a preprocessing neural network for flings crystal gap spacing of the sinogram data by utilizing full convolution network. The authors of [47] and [48] done investigation on Full convolutional GAN – Generative Adversarial Network by utilizing conditional GAN and cycle consistent GAN along with the network of VGG19 [50] which gets training along with the clinical data to have perceptual loss. The result of these illustrated that reduction in the FBP variance, MLEM – Maximum Likelihood Expectation Maximization reconstructions and bias. The cycle GAN deployment is better than the architecture of Deep PET in terms of SSIM and the PSNR. The authors of [51] have presented an architectural model which contains denoising serial models, reconstruction of images and trained with whole body 18F – FLT super resolution images. The authors made performance comparison with Deep PET networks and illustrated that SSIM and RMSE are enhanced. The over-all performance of the fully convolution neural networks is restricted because of the variations between the underlying signals that are measured in the sinogram space and the image space which is reconstructed. The authors of [52] proposed AUTOMAP, a neural network for the purpose of mapping common sensor space into the image space. The architecture of AUTOMAP does the transformation of the domains by utilizing the 3 feed-forward full connected layers and operations of the serial convolution. In context of the PET, a fully-connected layer gives the definition of system of learned inverse matrices that models relation between image space and the sinogram pixels, which are non-local. Even though authors [53 to 56] proposed only restricted number of PET application examples, the notion of understanding fully connected transform domain was used by the works which are particularly meant for reconstruction of sinogram PET information. A FBP – Net is a neural network that learns the filters available in frequency domains for sinogram data. This neural network uses fully connected learning layer with back-projection and de-noising CNN – Convolutional Neural Networks [53]. The network gets training over the data obtained from augmented digital phantom with the scaling, translations and rotations. Next, comparison of Unet and Deep PET was done for the evaluation purpose along with the FBP – Net. The result of comparison shows that FBP – Net is most robust for earlier unseen anatomy and over fitting. Supplementary research works included un-filtered back-projections as a transform domain without sinogram filtering space [54 and 55]. The authors of [54] proposed the bp-Net that uses un-filtered back-projection for preprocessing which is follows residual encoder-decoder networks on synthetic information. The authors of [55] use un-filtered back projections as the preprocessing step with cycle GAN and are trained with clinical information. Direct PET network was proposed by the authors of [56] that learns an optimal compression of sinogram and is high efficient in transform domain by using sinogram mask and maps to image space patch. Architectures of neural network consist of predefined transform domains, which perform better with the non-local relations between domains of image and sinogram voxels. This may be the more reliable alternate method to the fully CNN.

Results and discussion:

For the lena input image shown in Figure-3.a, filtering operation is done using Median filter and is shown in Figure-3.b. From the results of the median filter it is observed that the noise is minimized and the image is much clear and is useful for the next processing steps. The MSE - Mean Square Error calculation of Median filtered images is 33.446033 and PSNR - Peak Signal to Noise Ratio is 32.921353.

Figure - 3.a: Original image of Lena

Figure - 3.b: Median filtered image

For the lena input image shown in Figure-4.a, filtering operation is done using average/mean filter and is shown in Figure-4.b. From the results of the average/mean filter it is observed that the noise is minimized and the image is much clear and is useful for the next processing steps. The MSE - Mean Square Error calculation of Median filtered image is 31.504101 and PSNR - Peak Signal to Noise Ratio is 33.181128.

Figure-4.a: Original Lena Image

Figure-4.b: Median filtered Image

DEAD Node number	Intermediate nodes	Energy consumption
0	2	400.000000000000
0	4	399.381198993307
0	7	400.666909093273
0	4	399.933195701617
0	3	399.933195701617
0	5	399.933195701617
0	5	399.933195701617
0	0	399.933195701617
0	7	399.257340986381
0	3	398.708977510645
0	4	397.986443706848
0	5	402.571837315704
0	3	401.977438811456
0	6	401.247952165042
0	2	400.695382653632

0	5	400.695382653632
0	3	400.695382653632
0	4	400.695382653632
0	5	400.695382653632
0	3	402.402199975434
0	3	401.780988674923

Xd	Yd	G	Type	E	Energy	CL	ED	ED_RTP
63.2359246225410	0.0975404049994095	0	'N'	0.195652760375571	1	0	16.0080310701592	2
27.8498218867048	0.546881519204984	4	'C'	0.190386473237919	1	0	0	1
95.7506835434298	0.964888535199277	0	'N'	0.195929090100939	1	0	10.8377969932103	3
15.7613081677548	0.970592781760616	0	'N'	0.192505700091764	1	0	12.0959371347266	1
95.7166948242946	0.485375648722841	0	'N'	0.196369252800565	1	0	10.8130744678769	3
80.0280468888800	0.141886338627215	0	'N'	0.195427281913075	1	0	1.14901501341177	2
42.1761282626275	0.915735525189067	0	'N'	0.192471378631443	1	0	14.3310539617480	1
79.2207329559554	0.959492426392903	4	'C'	0.192160563924263	1	0	0	2
65.5740699156587	0.0357116785741896	0	'N'	0.192174276979772	1	0	13.6778939535823	2
84.9129305868777	0.933993247757551	4	'C'	0.194403810402121	1	0	0	3
67.8735154857774	0.757740130578333	0	'N'	0.189691220552701	1	0	11.3490108954209	2

74.3132468124916	0.392227019534168	0	'N'	0.193822034661464	1	0	4.94016298214017	2
65.5477890177557	0.171186687811562	0	'N'	0.193273889036642	1	0	13.6956497426969	2
70.6046088019609	0.0318328463774207	0	'N'	0.192875493252744	1	0	8.66591874722138	2
27.6922984960890	0.0461713906311539	0	'N'	0.193290493967739	1	0	0.524904040227862	1
9.71317812358475	0.823457828327293	0	'N'	0.191938190831040	1	0	18.1387524776400	1
69.4828622975817	0.317099480060861	0	'N'	0.195973248999672	1	0	9.75903651272570	2
95.0222048838355	0.0344460805029088	0	'N'	0.195809203418177	1	0	10.1492173056471	3
43.8744359656398	0.381558457093008	0	'N'	0.195467413115255	1	0	16.0254668603965	1
76.5516788149002	0.795199901137063	0	'N'	0.192760869998478	1	0	2.67410583966657	2
63.2359246225410	0.0975404049994095	0	'N'	0.195652760375571	1	0	16.0080310701592	2
27.8498218867048	0.546881519204984	4	'C'	0.190386473237919	1	0	0	1

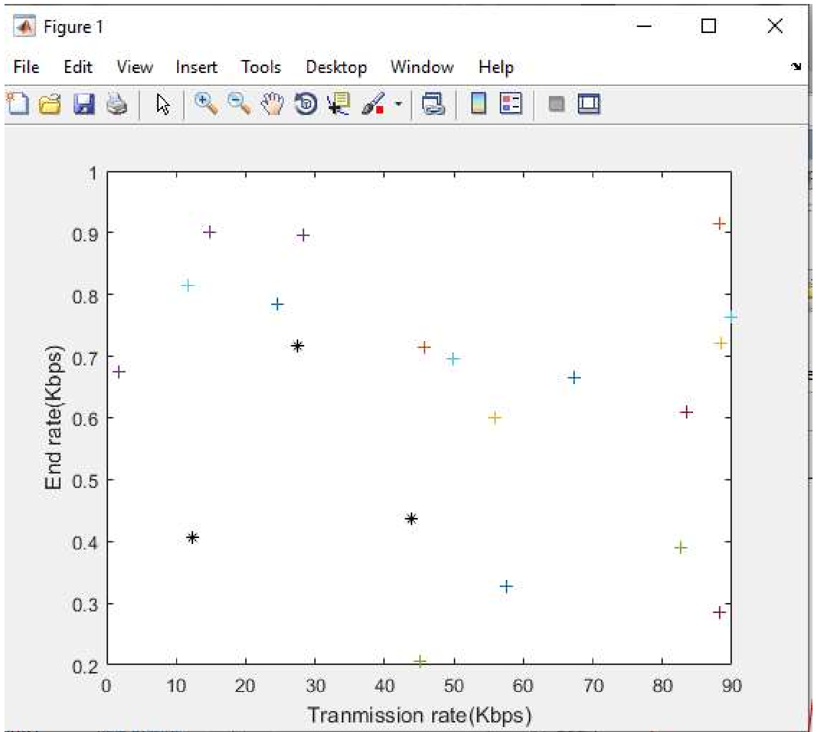


Figure 1
File Edit View Insert Tools Desktop Window Help
End rate(Kbps)
Tranmission rate(Kbps)
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0 10 20 30 40 50 60 70 80 90

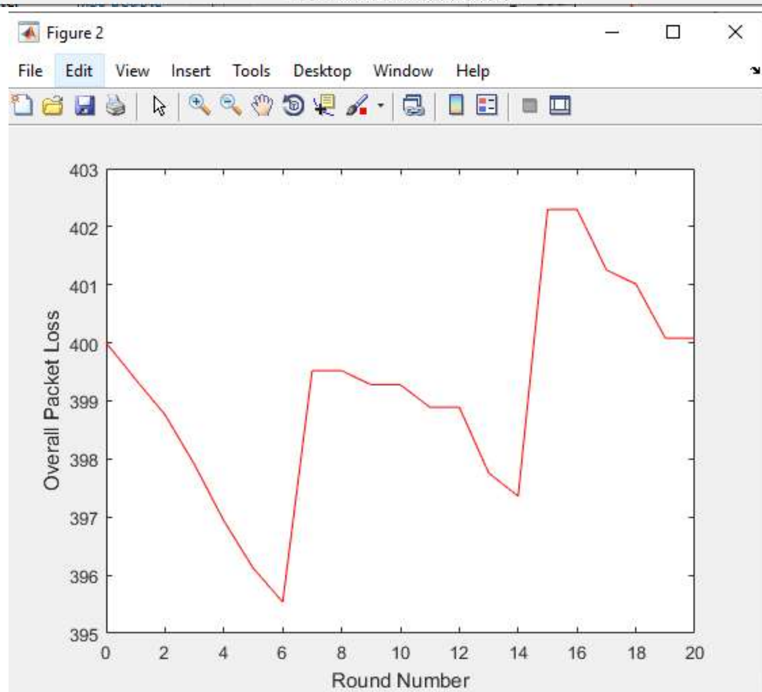
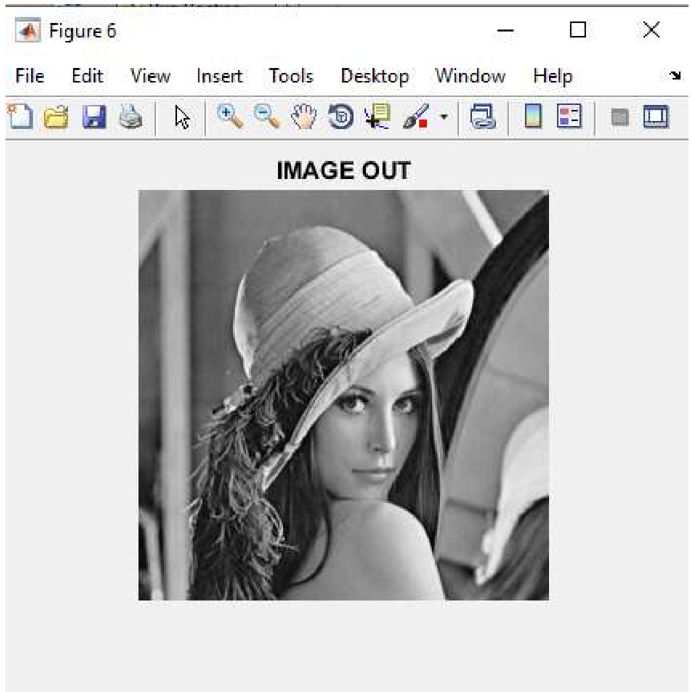


Figure 2
File Edit View Insert Tools Desktop Window Help
Overall Packet Loss
Round Number
403
402
401
400
399
398
397
396
395
0 2 4 6 8 10 12 14 16 18 20



Conclusion:

The cloud based implementing approach for processing an image is proposed. With the successful implementation of proposed work, the cloud environment using Thinkspeak is utilized in association with Matlab platform. Cloud computing based structure of distributed wireless sensor network distributed system will be constructed. The different parts of the acquiring image, storing and displaying individual part of processing image will be taken place. The design structure will be enhanced, with the distribution of encrypted image among the active nodes using RTP protocol. The considered node is active or dead is decided based on the energy level of the each node under communication. At the same time, the image encryption and decryption process is carried using ECC technique and RSA technique for the secure key exchange in an symmetric manner. The reconstructed image is compared with the original image and it is noted that the no significant modification observed due to secure protocol for the standard database images and the same can be continued for the raw database images as well.

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