# Secure Medical Image Compression & Transmission in WANET using Data Distribution Algorithm

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***Abstract*— Medical images are very important in medical field, it helps to diagnosis, treat and cure patients without causing any harmful side effects. Disaster area is a region where medical equipments and doctors are limited in number. So they couldn't reach to all affected patients. In order to reduce the diagnosis burden medical images collected from the primary health station to multi speciality hospitals where doctors medical equipments and are available. Medical images are being compressed for reducing the loss of energy occurred during transmission lines. Image compression is the process to reduce the size of the images in order to transmit effectively. Compressed image is send to the destination via WANET (Wireless Ad-Hoc Network) WANET is a type of wireless network without infrastructure. The nodes are distributed over the place for transmission. The objective of this work is to create a RMM System (Remote Medical Monitoring System) near to the disaster area which collects medical images of patients at the Primary Health Care Station (PHC) of the disaster area. The collected images are compressed to reduce transmission burden and transmitted to the WANETs. Medical images are most confidential, so as a part of the security encryption of compressed images are provided before transmission.**

***Keywords*— *Disaster area; image compression; medical images;RMM System***

## INTRODUCTION

A disaster is a natural or man-made events that negatively affects life, property, livelihood or industry often resulting in permanent changes to human societies, and environment. As the definition suggests, disasters are highly disruptive events that cause hardship, injury, suffering and even death, as a result of the interruption of commerce and business, injury, disease and the partial or total destruction of critical infrastructure such as bridges, power lines, hospitals, and roads, homes, etc. Disasters may be caused as naturally events, such as earthquakes, hurricanes, flooding, tornadoes, or can due to man-made events, either accidental (such as an accident or nuclear power plant event), or deliberately caused (such as various terrorist poisonings and bombings). Disaster area affects the population living in the community. In this area doctors are limited so patients didn’t get proper attention or treatment at right time. Difficult thing is cross checking of endoscopic images within the limited number of officials and limited time.

In this paper envisioning a scheme even a nurse can sent the endoscopic images to multi_speciality hospitals or to gather the diagnosis of medical images and prescriptions. By using these services even a single doctor can handle a medical team for a large number of patients. Here time spent by the doctor for consulting each and every report is saved. To reduce the time of uploading, image compression is used.

The main contributions of this paper are the following

- First, designing a RMM system placed near to the disaster area which collects the medical images of patients.
- Second, the collected images are compressed and transmitted to other hospitals.
- Third, to enhance security proposing encryption to the compressed images.

The remaining paper is organized as follows. Section II discusses related works. In section III, the proposed system has been described which includes system architecture. Section IV includes implementation details of the proposed system. Section V summarizes the contents of the paper.

## I. RELATED WORKS

In recent years many works has been done in the area of image compression and transmission through WANETs. Disaster responders to make correct decisions require timely delivery of high volumes of accurate data . An architecture, a set of protocols, and required services to support disaster response. The architecture, DistressNet,[5] is designed expressly for the alternately congested and sparse environments typical of a disaster area where conventional infrastructure is not available. Energy-efficient by nature, the network incorporates innovative distributed sensing enhanced with collaborative features designed to maximize coverage and minimize communications. A Spectrum-aware multichannel MAC protocol adds another element of energy efficiency by minimizing congestion through intelligent use of available frequencies. On-demand and delay tolerant routing serves both connected and disconnected segments of the network. Compartmentalization, coupled with fuzzy estimation techniques, provides accurate locations and supports situational awareness. Industry-standard networking allows hardware- and operating-system-agnostic messaging, supports heterogeneity at all levels, and ensures extensibility. All of these elements combine to provide first responders with detailed situational awareness suitable for mission-critical decision support.

In the few last years, there is an increasing need of QoS guarantees for multimedia and real time applications in mobile ad hoc networks.[2] While several QoS routing protocols were proposed, adaptive routing has not be enough exploited. We propose in this paper a new delay oriented adaptive routing protocol for mobile ad hoc networks. We integrate a mean delay estimation model at each node in our protocol in order to avoid synchronization problem. Adaptive mean delay routing (AMDR) protocol proposed in this paper uses two kinds of exploration packets having the task of gathering delay information of available paths and updating probabilistic routing tables. To reduce the overhead generated by AMDR protocol, we propose the use of a new MPR selection algorithm called Flooding Optimization Algorithm (FOA) based on mean delay.

A mobile ad hoc network[4] is a dynamic wireless network, which does not have fixed infrastructure. This paper presents a new multicast algorithm to increase the lifetime of node and network in the mobile ad hoc network. Here, it considers two

Metrics, namely residual-battery-capacity of the node and relay capacity of the node to do multicasting from the source to a group of destination nodes. The proposed model is simulated using network simulator-2.33 and is tested under various conditions. The proposed model is compared with the existing algorithms such as Multics-incremental-power, lifetime-aware-multiplicative,Multics-ad-hoc-on-demand-distance-vector protocol and multiple-path-multicast-ad-hoc on-demand vector. The proposed model shows the best results in terms of node lifetime, network lifetime and throughput.

A wireless capsule endoscope[3] with a suitable size for clinical application. The JPEG compression engine embedded in CMOS sensor makes it is possible to collect much more images for the WCE with the same power supply. This WCE system integrates a CMOS sensor with an optional JPEG Compression engine, a low power consumption high-performance micro-controller and an ultra low power RF transceiver in a small capsule (less than 10mm× 25mm). Experiment results show that this WCE system can collect much more images with its JPEG compression engine and the image quality can also be improved. In this paper, we will introduce the architecture of the WCE system. The experiment results and the performances of the system will also be presented.

A wireless ad hoc network (WANET)[1] is a wireless network aimed to be deployed in a disaster area in order to collect data of patients and increase medical facilities. The WANETs are composed of several small nodes scattered in the disaster area. The nodes are capable of sending (wirelessly) the collected medical data to the base stations. The limited battery power and the transmission of huge medical data require an energy efficient approach to preserve the quality service of WANETs. To solve this issue, here propose an optimization based medical data compression technique, which is decrease to transmission errors. Propose a fuzzy-logic-based route selection technique to deliver the compressed data that improves the lifetime of WANETs. The technique is fully distributed and does not use any geographical/location information. Here demonstrate the utility of the proposed work with simulation results. The results show that the proposed work effectively maintains connectivity of WANETs and prolongs network lifetime.

## II. PROPOSED SYSTEM

The idea behind the secure medical images is to improve the current image compression and also transmission of compressed image via routing. The Fig 1 shows the general flow of the RMM System. Here PHC denotes the Primary Health Care which is placed near to the disaster area. Here medical images are collected form the patients and compressed the image before transmission. For providing security encryption is performed in the compressed images. These images are sent to destination via WANETs. WANETs consist of of different nodes which placed over the disaster area. Life time of the node is the main challenges.

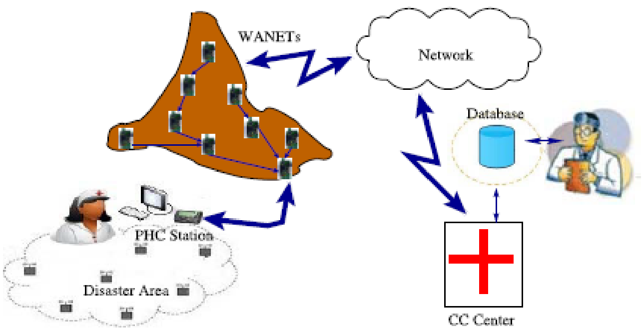


Fig.1. Proposed RMM System

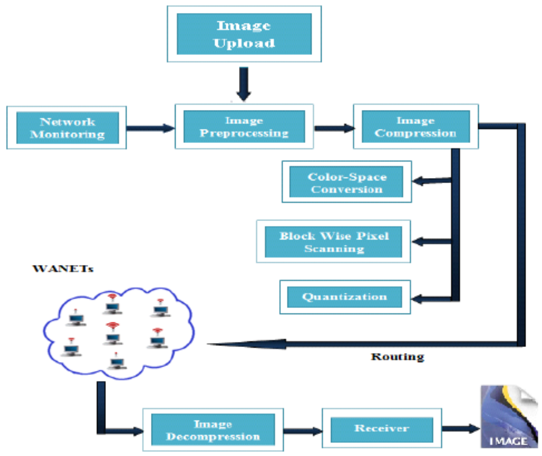


*Fig. 2. Architecture of the proposed system*

Fig. 2 illustrates the RMM System architecture. There are 3 processes are mainly occurring in this system they are compression, encryption and routing. Before compression network monitoring is performed. In network monitoring determine the server and clients. Prepare a list of active clients and also list the battery levels of clients. Compression is mainly used to reduce the size of image without any changes in that images. Compression helps to reduce the time of uploading medical images. Avoiding unauthorized access encryption is used. Compressed and encrypted image sent to WANETs where nodes are distributed over the disaster area. Routing is used in the case of traffic. That is path changes on each transaction. If battery life of the node is low for transmission select the suitable one.

## III. IMPLEMENTATION

In order to solve the challenges, and provide security encryption is carried out in compressed images. Secure medical image compression and transmission is implemented using c#.Net.

### *A. Medical Image Preprocessing*

Image preprocessing is the operation performed on the images at the lowest level of abstraction. Image preprocessing does not increase the image content. Image preprocessing is done at 2 steps they are gray scale conversion and image matrix generation.

a) Gray scale Conversion
It is the simple procedure and performed using the following functions.

$$y=f(x)$$

where,
x - original input data
y - converted output data
Linear conversion is performed at the image that is

$$y=ax+b$$

where,
a - gain
b – offset
After performing gray scale conversion the image matrix is generated.

### *B. Medical Image Compression*

Medical image compression technique is mainly divided into 2 process. They are image transformation and encoding coefficients.

a) Image Transformation
The medical images are represented in RGB color planes. So independent color plane conversion is not possible. An adaptive color space conversion is possible for better result. Image transformation of endoscopic images take several processing steps. They are listed below

1. Color Space Pixel Conversion
Since performing medical image compression YUVr or YcgCo-R is used because it provides low entropy and without any data loss.
2. Block Wise Pixel Scanning
To avoid computational burden the input image is divided into non overlapping blocks. This helps to reduce the memory requirements and computational complexity. For higher compression the size of each block is 4x4.
3. Transformation and Quantization
DCT coefficients are real numbers. Processing of the real numbers increase complexity. 2Dinteger DCT(Int DCT) is used for transformation and quantization. IntDCT helps to visually loss less compression. The coefficients obtained from the block transform is encoded using an encoder.

b) Encoding of Co-efficients
Coefficients obtained from the blocks are labeled as AC and DC coefficients. At first DC coefficients are differentially encoded, that is the previous block's coefficients are used as the predicted value of the current block. The encoded DC coefficients are then encoded using Adaptive Golomb Rice(AGR)code. AGR encoder rule is defined below

$$G(u,k) = \underbrace{11\cdots1}_{\text{prefix,pbits}}\,0\underbrace{b_{k-1}b_{k-2}\cdots b_0}_{\text{suffixz,kbits}}$$

The AGR encoder encodes the positive integer u has prefix and suffix strings. AGR encoder encodes only non negative integers. The following mapping function is used for transforming DC coefficients to non negative integers, which is given by,

$$M_1(d) = \begin{cases} 2d & \text{if}\,(d \geq 0) \\ 2|d|-1 & \text{otherwise,} \end{cases}$$

Where, d and |d| represents DC coefficients and its absolute value. AC coefficients are quantized to zero it is the property of IntDCT. Low frequency AC coefficients are signed, mapping function $M_2(e)$ is used to transform non zero AC coefficient e to a positive integer.

Mapping function is,

$$M_2(e) = \{M_1(e) : \ e \in \mathbb{Z}_{\neq 0}\}.$$

Reduction of Artifacts Noises

Presence of artifacts in medical images leads to misdiagnosis. Blocking of the image matrix results in discontinuities across block boundaries. *Adaptive Edge based fuzzy filtering method* based on slope of the pixel is used to avoid this.

The pixels are first classified into edge pixels and non edge pixels. The classification of the pixels is done by comparing amplitude of the slope to a threshold, it is denoted by th. Edge pixels are not filtered, filtering may blur the edges. For non edge pixels with stair case noise with ringing artifacts are filtered with an isotropic fuzzy filter. The result of medical image compression is obtained at the PHC station are visually loss-less and ready for diagnosis.

*C. Secure Transmission*

For achieving the security for the images here encryption techniques are used in the compressed images.

1. Get the data to be encrypted and the selected key.
2. Create two string arrays.
3. Numbers from 0 to 255 to initiate one array.
4. Fill the other array with the selected key.
5. Depending on the array of the key, randomize the initial array .
6. To generate the final key stream randomize the first array within itself.
7. The data to be encrypted to give cipher text, XOR the final key stream with the data.

Encrypted medical image are ready for transmissoin. Routing is the technique used for transmission. Fuzzy Logic Based Routing Selection Technique is used for transmission. This technique reduces the energy consumption and increases the life time of nodes which is placed over the disaster area.

In an ad-hoc network the major challenge is, if some nodes are go down or in the case of node failure it is also assumes that the nodes can still send the data to the hospitals. To avoid these an energy consumption model is established.

*Energy Consumption Model*

When a node transmit k bit message directly to a reciever node over a distance d, the energy consumed ($E_t$(k,d)) for transmission and ($E_r$(k)) for reception, which is calculated as follows:

$$E_r(k) = k \times E_{elect} \quad \text{and} \quad E_t(k,d) = k \times (E_{elect} + \varepsilon_{amp} d^2),$$

*Fuzzy Logic Based Route Selection Technique*

This system performs its work with mainly 4 steps: fuzzifier, fuzzy interface engine, rule base and defuzzifier. At the starting an input is applied to the system, the fuzzy interface engine compute output set corresponding to each rule base. All rules in the rule base are processed in parallel. The defuzzifier performs defuzzification to a single output value. Here consider m input and i output. It uses if-then rules

$$\textbf{IF}\ input_1 \rightarrow x_1\ \textbf{and}\ input_2 \rightarrow x_2\ \textbf{and}\ \cdots\ input_m \rightarrow x_m,\ \textbf{THEN}\ output \rightarrow y.$$

The inputs given to the system are energy consumption, residual energy and routing delay. The output from the system is denoted by *select_routing_metric*, which is the probability of a path selected for transmission. Technique for getting the output is given in the table below

| $I_1$ | $I_2$ | $I_3$ | LV | $I_1$ | $I_2$ | $I_3$ | LV | $I_1$ | $I_2$ | $I_3$ | LV |
|---|---|---|---|---|---|---|---|---|---|---|---|
| L | H | H | M | M | H | H | L | H | H | H | VL |
| L | H | M | VH | M | H | M | H | H | H | M | M |
| L | H | L | VH | M | H | L | H | H | H | L | M |
| L | M | H | M | M | M | H | L | H | M | H | VL |
| L | M | M | H | M | M | M | M | H | M | M | L |
| L | M | L | VH | M | M | L | H | H | M | L | M |
| L | L | H | H | M | L | H | M | H | L | H | L |
| L | L | M | M | M | L | M | L | H | L | M | VL |
| L | L | L | H | M | L | L | M | H | L | L | L |

where,

$I_1$- energy consumption
$I_2$- residual energy
$I_3$- routing delay
*LV*- Linguistic variable
*VH*- very high
*H*- high
*M*- medium
*L*- Low
*VL*- very low

A path having higher value in the *Select_Routing_Metric* is selected as current path. Here energy consumption denotes an energy efficient path which increases the lifetime of nodes in the WANETs. Let $E_{ik}^{ab}$ denotes the energy for transmit k bit messages of compressed medical images between nodes a to b via $i^{th}$ path, which is calculated as

$$E_{ik}^{ab} = \sum_{j=1}^{h_i} \left(k \times (E_{elect} + \varepsilon_{amp} \left\| h_{ij} \right\|^2) + k \times E_{elect}\right)$$

where $h_{ij}$ and $\|h_{ij}\|$ denotes the hope count and the length of $j^{th}$ hope in the $i^{th}$ path respectively. For an illustration a scenario where s is the source and t is the destination node. A relay node c receives two messages from nodes b and d. By using the above equation energy required to transmit data between s and c is $E_{1k}^{sc}$ ={2+2+2} and $E_{2k}^{sc}$ ={2+3}.

The nodes are given below

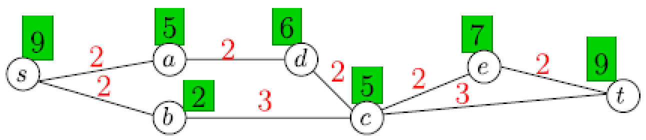


Fig. 3. An example of fuzzy route selection technique

Residual Energy helps to avoid nodes from being over used it helps to increase the lifetime of nodes. The value of linguistic variable are either words or sentences in natural languages. The delay to transmit data between source and destination is termed as Routing Delay.

## IV.CONCLUSION

RMM is a medical monitoring system. Patients medical data, which is in the form of images is collected and securely transmitted to the CC center. Before transmission compression is performed to the image to reduce the energy loss occurred during transmission and avoid the overhead of bandwidth in communication channels. Image compression is a combination of various operations they are image preprocessing, color space conversion, block wise pixel scanning, quantization and encoding coefficient. Since compression in medical images an adaptive edge based fuzzy filtering algorithm is used to reduce noises. Prevent unauthorized access of compress data is avoided by encryption. And then the encrypted packet is sent to the WANET using fuzzy logic based route selection technique. .

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