Optimizing Wireless Multimedia Sensor Networks Path Selection using Resource Levelling Technique in Transmitting Endoscopy Biomedical data

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Abstract. The urge to transmit especially biomedical data rapidly is essential to save human life. Every user demands for high speed communication with no delay. But the network suffers from huge delay which degrades the performance of the network and it also dissatisfies the user expectation. To meet the user needs, the proposed work mainly focuses on increasing the speed and minimizing the delay in communication using Internet applied in Things (IoT) and Wireless Multimedia Sensor Networks. It can be achieved by avoiding over allocation of resources in the network i.e., resource level balancing and planning the transmission. These two have greater impact in upgrading the performance of network. This paper introduces a unique methodology for Wireless Multimedia Sensor Networks and end-device assisted system. The transmission time can reduced by using the concept of probability estimation for crashing the interpretative path. It extends the battery level of the motes by enhancing the pace and minimizing the energy level during transmission process. The Crashing Interpretative path protocol is simulated against other literature method. The simulation results shows that the CCP provides better efficiency in terms of transmission time, the lifetime of sensors for biomedical data transmission. This methodology is greatly helpful to save precious human life.

Keywords—Wireless Multimedia Sensor Networks, biomedical data, interpretative path, delay, scheduling, resource leveling.

1. Introduction

Wireless Multimedia Sensor Networks is a self-configured network contains a group of sensors to monitor and record environmental conditions like temperature, pollution levels, humidity, wind speed, sound, vibration, pressure etc. Sensors transmit the information wirelessly to a main location known as destination point where the information can be observed and analyzed. Evolution of Internet-of-Things (IoT), The Internet applied in Vehicles (IoV) and more recent Internet of Everything (IoE) stimulate the deployment of Wireless Multimedia Sensor Networks in large scale. As the sensors solely depend on its battery power for sensing and transmitting the information it should be effectively utilized. In a sensor network model, the cluster formation plays a vital role...
in order to perform specific tasks in an effective way. These tasks with specific functionalities are used to improve the efficiency of the working environment. Performance has been analyzed while sending the status or controlling the data from large amount of sensors, with the help of different middleware and standards.

In Wireless Multimedia Sensor Networks, as the environment is mobile the process of stabilizing routing paths is interpretative. Network will get failure mainly because of continuous depletion of battery and also adequate to malevolent scheme and pursued by cutting down the mote. More care must be taken before choosing the routing protocol for the transmission. As the information has to be transmitted by using the intermediate nodes in turn it will utilize the battery power of the intermediate nodes. Battery power of the sensors has to be considered before choosing the path for the transmission will minimize the failure of the network. Malicious activity can be stopped by constructing interpretative paths after cutting down the unnecessary nodes. Moreover, the transmission speed will be increased by reduced timely interpretative paths leads to crashing actions in WSNs.

![Interpretative Path between source and destination](https://via.placeholder.com/150)

**Figure 1.** Interpretative Path between source and destination

In an unchanging environment, the dissected path cannot be formed spontaneously, and patch node should be inserted to fulfill the vector path. In case of mobile environment the disjoint topology can be updated by joining the active nodes in a suitable way which forms the Interpretative Path. If interpretative path is identified as the longer distance path then it consumes more amount of battery of the sensor.

To solve this issue, reducing number of interpretative path plays an important role in reducing the consumption of battery for long distance transmission. The proposed method will extend the lifetime of the mote which in turn makes the network to serve in an efficient and effective manner.

### 2. Related work

The communication of data packets from source node to sink node is one of the main issue which attracts most of the researchers. Reliability defines how fast the network will come to live if there is any path loss. It has to consider in case of WSN as lot of research has already been proposed. In WSN environment the network will consists of sink and sender nodes. These nodes will be connected in order to form a network. If a node fails then entire network will come down because of network partition. Hence if we want a network to be energy efficient then reconstructing the path is case of path loss will be effective solution. The new path constructed in case of failure will consider node lifetime in to account.

Reactive and proactive are the two different mechanisms in order to recover from network partition problem. Proactive protocols will have additional connection in order to recover if there is any path loss occurs. But more number of path will create the k-1 node failure problem which will become the burden for cluster head. Lee et.al proposed Relay node as the solution in case of network partition problem. It was used in a Connectivity Restoration Algorithm for Fault Tolerance system. Threshold level will be defined up to which relay nodes can be positioned in order to overcome that problem. It has the border limit such as backbone polygon in order to limit the relay node to be placed inside the topology.
3. System model

![System diagram](image)

**Figure 2.** WSN architecture for medical application

The medical center can have necessary biomedical images which could be taken from the hometown will be compressed and transmitted by the wireless sensor network will be stored in a centralized repository from there the medical expert across the country can access it and provide the necessary advice for further diagnosis.

WSN consists of nodes with minimal battery power. It also has a responsibility to transfer the data frequently. Since we are considering the medical data transmission it is effective only without any data loss. In order to preserve the lifetime of the nodes in WSN medical images are compressed and sent by a technique called Medical Image Compression Scheme (MICS).

Any loss or deviation in the medical data transmission will leads to false diagnosis. To solve this interpretative requirement only lossless image compression methods could be used. Lossless techniques are mostly used for compression process while transmitting the medical images. These methods will yield a good result only in a high bit rate transmission.

![Medical image compression scheme](image)

**Figure 3.** Novel Medical Image Compression Scheme

The goal of the work is divided into two phases. First phase is to provide a highly compressed medical image without any data loss and also with the better quality. Second phase is to transmit such an image in a shortest path using PERT-CPM method. In this work, the color images of endoscopy are considered.

The images captured in endoscopy are usually colored images. As like the normal color images these endoscopic colored images also represented by three coordinates named as RGB values. The technique of compressing these three planes separately is not an efficient one because of the high correlation values. So we
are in a urge to apply the color-space conversion techniques in order to acquire the compressed images with no distortion. The processing steps are as follows.

3.1 Pre-processing

In pre-processing the captured image is transformed into gray image which is then changed into binary image. The contrast between the components has been increased by histogram equalization technique. The reason behind the color conversion is to reduce the number of colors. The RGB components together uses 24-bit color value whereas gray scale utilizes only 8-bit for calculation.

![Figure 4. RGB endoscopic images](image)

The results of MICS and PERT-CRM are implemented in MATLAB 7.1 and NS 2.3.4 simulators respectively. The MICS technique produces compressed medical images at the respective health centers from the captured colored endoscopic images of various patients. The compressed images will be decompressed at the respective platforms where the medical expert is witnessing the images and providing required diagnosis to the needy patients. The transmission noises are removed before decompressing the images at the workplace of the medical experts. These compressed medical images of the patients are transmitted via the WSN. The health centers will be acting as a source and the workplace of the medical experts will be acting as a destination for the PERT-CRM scheme.

![Figure 5. Histogram values before compression](image)

![Figure 6. Gray scale conversion of RGB endoscopy image](image)

![Figure 7. After applying MICS scheme](image)
3.2 Noise reduction

The proposed method called as looping bi-lateral filter (LBF) is used for noise reduction. The type of the filter is non-linear. Its performance towards edge deduction is effective than a median filter.

1. The captured image is changed to gray scale from RGB format. Less correlated component planes will be generated from the above images.
2. The inter pixel correlation will be reduced and the pixel intensity will be transformed into suitable coefficients of transformation.
3. The whole plane will be splitted into unoverlapping blocks. These resultant blocks are quantized by blocked IntDCT.
4. The hardware encoder is used to obtain coefficients of each block.
5. These coefficients are mapped on to a positive integer values using the equation.

Let us consider the coefficient will be stored in a variable ‘d’. The mapping function will be generalized as:

\[ F(d) = \begin{cases} 
3d, & \text{if}(d>0) \\
0, & \text{otherwise} 
\end{cases} \]

6. Criss-cross pattern is used to map the non-zero positive values.
7. Thus by eliminating the zero valued coefficients the pixels sizes of the images are reduced to an extent.
8. Thus a compressed image is obtained.

4. Performance analysis

![Figure 8. Difference in bit values of storing RGB and Gray scale images](image)

An endoscopic dataset of 300 images each of 512 X 512 resolutions is analyzed. The proposed MICS has been compared with JPEG and JPEG2000 schemes of compression. The results are tested for transmission errors, range of compression and network lifetime of WSN.
4.1 Colliding the Interpretative Path

Manual power, required tools and cost are to be the common and desired requirements of the project planning activity. Each and every resource usage has its own limitations and constraints. The main resource requirements of the interpretative activities are adjusted between the Advanced beginning times and recent completion times of non-interpretative tasks so that the interpretative activities may not be affected due to the peak requirement of resources. This section addresses the complications like Resource leveling and resource allocation.

4.2. Resource Leveling Procedure

This resource leveling technique overlooks the resource allocation to reduce the most prioritized requirement of the resource. And also it smooths out the timely variation by unchanging the most important factor of project finishing time. Table I lists out all the activities and its extent of the time it is taking.

| Pursuit | Transmission time (ms) | Destination point forwarded |
|---------|------------------------|----------------------------|
| 1-3     | 6                      | 5                          |
| 1-4     | 20                     | 2                          |
| 1-2     | 8                      | 4                          |
| 1-5     | 12                     | 6                          |
| 2-5     | 4                      | 5                          |
| 4-6     | 10                     | 6                          |
| 2-4     | 12                     | 4                          |

The above Table I gives the information like no. of sensors, their transmission time and the destination point to be forwarded. For finding the interpretative path between any source and destination, first Advanced starting time is computed for each node. Then the Advanced Completion Time is calculated. Finally the slack is computed by subtracting the Advanced Starting Time and Advanced Completion Time. If the slack value is 0 then that particular node is interpretative node. The sequence of interpretative nodes from source to destination is interpretative sequence. The steps are given below for the source node 1 and destination 2.

Initialization Advanced Start Time (i) = 0

Destination (DS) = 2

The formula to calculate Advanced Start Time is
Advanced Start Time = Maximum (Advanced Start-Time (i) + Destination)

The steps to be followed are as follows:

Step 1: Initially it is added with the second node distance
Advanced Start Time (2) = 20(8+12), if it is traversed via
1->4->2.

Step 2: If the transmission happens through the route 1->3->5 then the
Advanced Start Time (5)=10(6+4),
Or, if the route is 1->2->5, then
Advanced Start Time (5)=12(8+4).

Step 3: If the transmission happens through the route 1->2->4->6 then the
Advanced Start Time (5)=10(6+4),
Or, if the route is 1->2->5, then
Advanced Start Time (4) = 20(8+12).

Step 4: The latest Completion Time is calculated by the next Successor node with the smallest transmission time.
So,
Latest Completion Time (6)=30

Step 5: Go by the predecessor of node 6, then the
Latest Completion time (5) =30-10=20.

Step 6: For every node in the transmission, subtract the transmission time from the predecessor to calculate the
Latest Completion Time of each node.

Step 7: Finally get the initial value for the starting node.

Figure 10. Example node arrangement based on Table 1

Repetition 1: Now consider the movement of packet from source 1 to final destination 2. First compute the
Advanced beginning schedule of the packet transmission and its duration. The Figure 11 shows the
minimized duration of Network schedule for Repetition 1.
The above mentioned Figure 11 depicts the status of the network after scheduling in Repetition 1 and the consequent resource level balancing is given in Figure 12.

Figure 11. Result of Repetition 1 Network schedule

Repetition 2: In the Figure 13, the activities scheduled are 1-4, 4-6. The activity 1-4 is interpretative. So, it should not be concerned. The slack is calculated based on the calculation.

Figure 13. Result of Repetition 2 Network schedule.
Figure 13 shows the scheduled network based on the repetition 2 and as a consequence Figure 14 shows the resource leveling technique applied.

![Figure 14. Resource leveling (Repetition 2)](image)

Figure 15 and 16 present the current network schedule and its resource leveling result.

Repetition 3. The Figure 15 depicts the information regarding the expected number of motes. For this repetition 3 it is 20. It can be used for implementing the colliding of interpretative path and resource allocation. So, this technique is considered to be an effective one that reduces the packet transfer time.

![Figure 15. Result of Repetition 3 Network schedule.](image)
5. Problematic Declaration and its Resolution

To prolong the performance of a network, the partitions or segments i.e., disjoint topology must be identified and connected. It is very helpful for collaborative authentication works. It also reduces the delay that happens in communication via longest path.

5.1 Constricting the Interpretative Path

The packet transmission path can be formed by positioning all other neighbor nodes. But the neighbor nodes must be authenticated nodes. The total count of nodes which is needed to avoid repartitioning can be computed by the following equations (1) and (2).

\[ N_D = \sum_{i=0}^{N_{D-1}} (\sum_{j=0}^{N_{D-1}} j \neq i \text{Cycle}(I_i, I_j)) \]  

--- (1)

Where, \( N_D \) = Total nodes to be positioned

\[ \text{Cycle}(I_i, I_j) = N_D, i = 0, \ldots N(i) - 1, I_i \neq I_j \text{Cycle} \]  

--- (2)

Where, \( I_i \) & \( I_j \) are middleware or gateway to the splitting topology.

The Crashing Interpretative Path algorithm concentrates on rejoining the network for again transmitting the packet from source node to the destination node. If the identified path is longest one then it can be compressed to minimize the transmission delay.
5.2 CCP protocol approach

**Algorithm 1.** Crashing Interpretative path

In the network so many are available and there may a chance of node failure. But all the nodes will be connected to form a network based on some topology. On node failure, the packets destined to that node will fail. As a solution, availability other paths are analyzed and identified for again transmission of the packets. In network, if any node failure occurs then the path gets lost. Again the interpretative path is identified even though it is longest path. But in order to minimize the packet transmission delay, link compression may be done.

6. Results and Discussion

6.1 Simulation parameters

The sensors are deployed within 1500 m by 900m area. The transmission radius is 100m. The nodes are scattered from 60 to 400. The suggested methodology is evaluated by the following list of metrics and the various parameter settings necessary for simulation is given in the Table II.

1) **No. of disconnect links**: The links which causes the repeated construction and transmission of the packets are counted.
2) **Ratio of Packet transfer**: Successfully received packets (in terms of percent).
3) **Count of multiple paths**: Count of the available alternate paths for failure recovery.
4) **Delay**: Comparison between previous link and reconstructed link based on delay.
5) **Colliding interpretative path**: It measures the distance between the source and the point where the packet dropped. It is used for reconstructing the path.

| Parameters                        | Values                        |
|-----------------------------------|-------------------------------|
| Total area                        | 1500 m * 900 m                |
| Approximate count of sensors      | 60 to 400                     |
| Transmission range in terms of radius | 150m                        |
| Total time taken for Simulation   | 1000 ms                       |
| Range of the radio                | 300m                          |
| Source for the traffic            | CBR                           |
| Distribution model                | Random graph                  |
| Regaining time                    | 100 ms                        |
| Packet queue up                   | Drop tail                     |
| Name of the protocol used         | CCP                           |
| Size of the packet                | 512 bytes                     |
| Movement model                    | Random way point              |

### 6.2. Results

Initially the simulation environment set up is done as per the parameter settings in table 2. The conduct of the CCP algorithm is collated with existing algorithms. The CCP algorithm outperforms against all the available paths and as a result the reduced delay is depicted in CCP along the longest line.

**Figure 17.** Simulated Wireless Sensor Network

The network environment can be made upon desired number of nodes. Figure 17 shows the model arrangement of wireless network. The motes are deployed in the environment in a random manner. Similarly, the Figure 18 shows the transmission of packet from source mote to destination node. If the authentication of any en-route node is failed, then that node is cut down from its path. This results in disjoint network. Figure 19 reveals the path isolated by cut down process. Figure 20 detects the multiple paths in order to do recovery process from source node to destination.
The packet missing or dropping can be avoided by connecting the partitions. To do this, interpretative path must be created from the available multiple paths from source to destination. So, first we need to find all the possible paths in the network environment. This way of exploring the paths is given in the Figure 21. Then the interpretative path can be discovered by computing slack value, which is depicted in Figure 22.
Figure 21. Identifying various path

Figure 22. Establishing interpretative path

Figure 23. Transfer Speed of the packets in CRAFT algorithm

Figure 23 shows the speed of the packet transmitted in CCP algorithm. It proves that the speed is high from source to destination.

The CCP algorithm is collated with 2 algorithms namely CRAFT and EPSICA algorithm. The packet
transmission speed of CRAFT is shown in the Figure 24. Here, the packet transfer speed goes on reducing along the longest path from source to destination. Consequently on reaching the destination, the delay gets increases.

![Figure 24. Analysis of Transfer Speed of the packets in CCP](image)

Figure 24. Analysis of Transfer Speed of the packets in CCP

Figure 25 shows the comparison between the delays of the recently existing algorithms. It determines that the CCP algorithm transfer the data from source node to destination with minimum delay comparing with CRAFT and EPSICA.

![Figure 25. Delay comparisons among CRAFT, EPSICA & CCP](image)

Figure 25. Delay comparisons among CRAFT, EPSICA & CCP

7. **Conclusion**

In this paper, a network with ‘n’ number of nodes is located and the optimal algorithm i.e., Crashing Interpretative Path is executed upon them. The main aim is to minimize the transmission delay and improves the communication speed in the wireless sensor network. The simulation results shows that the CCP algorithm minimum network delay and provides high performance. It is also compared with algorithms in literature papers. The comparison result projects clearly that CCP algorithm has minimum network delay and the performance is also high while comparing with CRAFT and MPSICA routing algorithms. The Same algorithm can be extended by including some security features as a future work.
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