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SPECIAL ISSUE ON RECENT RESEARCH CHALLENGES IN BIO-MEDICAL APPLICATIONS

An Effective Approach for Bio-Medical Data Transmission Using Hop Scheduled Data Dissemination Through VANET

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Now -a-days health problems has been a major concern and monitoring the patients has become a significant part of various healthcare services. If the vital signals such as blood pressure, ECG, pulse and blood oxygenation of patients are disseminated to the physicians or doctors in real time then the likelihood of saving the patient's life considerably increases. Thus in this paper VANET technology has been exploited to collect data from the patients and transmit it to the final destination. Here, a hop scheduled data dissemination algorithm has been proposed to disseminate huge amount of medical data to hospitals. Prior to transmission, the medical data are encoded with transmission frequency using polynomial function to allow efficient transmission. Simulations are carried out to analyze the effectiveness of the proposed approach.

Key words: Medical data, VANET, Encoding.

Exploitation of information technology in all fields has achieved a great significance and among these fields electronic health (eHealth) has been considered as a time critical application that offers solution to the universal problem of patients' health. With the advent of the technology the physician at the medical center can be aware of the patients' locations and analyze the health information of the patients and if the patient is in critical condition an ambulance will be sent to the patients' place.

Earlier, mobile and wireless technologies were employed in monitoring the patients over various environments such as hospitals, homes and so on, but due to the unpredictable coverage of users the reliability of monitoring patients is not satisfactory. Thus the concept of VANET technology[1, 2] has been exploited to collect data from the patients and transmit it to the final destination. In VANET vehicle communicate with each other and the road side unit (RSU)[3]. The RSU acts as a buffering point as well as a router to offer communication among vehicles[4]. Each devices are equipped with wireless devices with standards like dedicated short range communication (DSRC) and the communication between the vehicles is achieved by data dissemination techniques which allow a vehicle to carry data packet with it until it identifies another vehicle within its vicinity that is moving in the direction of the destination and then forwards the data packet to the particular vehicle. But transmitting the significant information in an effective manner is vital under this setting since these information's are critical lifesaving information.

Basically there are two kinds of communications in vehicular network: one in which a slight delay is acceptable. Examples of delay tolerable applications include advertisement messages, parking condition and so on. On the other hand there are situations in which even a slight delay might be accountable for loss of life. Thus for sending emergency information's in VANET broadcasting scheme is generally utilized.

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The key advantage of employing broadcasting technique is that it is not required for the vehicle to know the path to the particular destination. It generally spreads the emergency message rapidly. But broadcasting the same information in a huge volume will create contention and cause collision. Moreover rebroadcasting in case of transmission failure makes the situation worse. This is termed as broadcast storm issue. To solve this issue, several researchers employed a technique in which only a portion of the vehicle is selected for disseminating the information.

Thus, in this paper an effective data dissemination technique has been proposed to transmit the huge volume of medical data in reliable and efficient manner to the destination. The approach introduced is hop scheduled data dissemination algorithm which is based on AOMDV routing protocol. To allow effective transmission of huge volume of data this approach encodes the emergency message along the active transmission using polynomial function.

Related Work

Recent introduction of advanced communication devices and sensors have paved the way for developing systems to gather information from places where emergency situation have raised[5, 6]. In this section we will review some of the research work that has been made in the health care domain and techniques employed for the effective dissemination of packets in VANET.

In[7] vehicular network has been used as system of gathering patients' pre-stored physiological information and reconfigures wearable systems so as to enable to select only those data that are particularly requested by the doctors. In order to achieve this, author exploited IEEE 802.11g communication link. In[8] Medical Data Transmission Over Cellular Network (MEDTOC) scheme has been proposed for effective transmission of multiple patients' health data from ambulance to medical center. The MEDTOC scheme utilizes UMTS technology for transmitting the imperative signals to hospitals with limited bandwidth.

In[9] authors intend to transmit the health information towards a vital unit using the contacts that takes place between the patients. But the authors restrict their investigation to pedestrian models not considering the possibility that arise from the utilization of emergency vehicles. In[10] the issue of patient-vehicle contact time has been addressed using practical model. In this experiment it has been observed that the road segment impacts vehicle's average speed and it is analyzed that the emergency vehicle will traverse the particular road section in one third of its traversal.[11] Presents telemedicine data transmission using the cellular network and standard HL7 V3 for data modeling. The data is disseminated to a web server and a centralized database is used for the storage for data sharing with other specialists.

In[12] patient's health information has been transmitted to hospitals over VANET technology using Bluetooth technology. In[13] an LT-code based approach has been proposed to transmit huge volume of medical information from ambulance to medical center. But a major issue in VANET is how to transmit information or messages in VANET in a scalable manner. In[14] a data dissemination technique has been introduced which is applicable to both on-demand unicast and broadcasting scenario. The author proposes propose a weighted K-nearest neighbors prediction technique along with self-feedback to forecast the current vehicle speed and create a list of forwarders to broadcast the emergency information. In order to fulfill the users' demand, the author designed a unicast mechanism that is based on improved Greedy Perimeter Stateless Routing protocol and the information urgent level.

In[15] Profile-driven Adaptive Warning Dissemination Scheme (PAWDS) has been designed in order to enhance the dissemination of warning messages. This scheme dynamically changes key parameters of the transmission process and locates the vehicles that are in dangerous situation and sends the warning messages immediately to all the nearby vehicles. In[16] developed a dynamic routing system by incorporating the metro rail network along with road transport system to direct the ambulances. Dijkstra's algorithm has been used for discovering the shortest path by considering the time variable. The results shows that it reduce the travel time and minimize the response time of ambulance.

In[17] Vehicle Density Dependent Data Delivery (VD4) protocol has been proposed for effective data transmission. The path with minimum acceptable delay is chosen for transmitting the data packet. In this scheme the packet is transmitted to the RSU and the RSU transmits the packet to the vehicle that is traversing in the optimal road towards the destination. In[18] a fuzzy logic approach with multi-criteria decision making

MATERIALS AND METHODS

Assumptions

We assume that patients are implanted with health monitoring devices and they walk along the roads and there arises a situation to transmit the health information to the doctors or medical centers. The health monitoring system comprises of the following components: sensor which is responsible for sensing the vital parameters of the patients' body, a data processing unit such as mica2 motes for transferring the sensor data to the on-body terminal unit, an on-body terminal unit collects the data transmitted by the processing unit and forwards it to the outside vehicles. Each vehicle is equipped with mica2 mote and GPS device that advertises its IP address and location constantly. The on board terminal utilizes this IP address to initiate the communication. It is assumed that the source vehicle utilizes a single path to communicate with its one hop neighbor vehicles and the neighboring vehicles acting as a relay nodes can use the multiple paths to send the medical data to the hospital. This approach does not support passive acknowledgement scheme which reduces the retransmission overhead. Fig 1 shows a typical data dissemination scenario between the patients and the hospital via VANET.

Effective Data Dissemination

The vehicles equipped with mica2 mote and GPS device traverses along the roads and broadcast advertisement messages that include their IP address and location information. When the on-board terminal unit of the health monitoring system notifies the advertisement message it transmits the medical data including ID of the destination to the corresponding vehicle of the IP address present in the advertisement message. Once a vehicle receives the emergency message it starts transmission of data to the desired destination in a multi hop fashion. In this research work, Hop scheduled data dissemination (SDD) algorithm has employed for efficient transmission of medical data.

Hop Scheduled Data Dissemination (SDD)

The SDD algorithm is based on the ad hoc on-demand multipath distance vector (AOMDV) routing protocol. In SDD algorithm the source vehicle identifies its one hop neighbors using the location information broadcasted by the vehicles. Once the one hop neighbors have been identified the source vehicle checks for the bandwidth and hop consistency of its one hop neighbors. The node (vehicle) with sufficient bandwidth and better hop consistency is chosen and then the source transmits the data to the vehicle that is being selected utilizing single path.

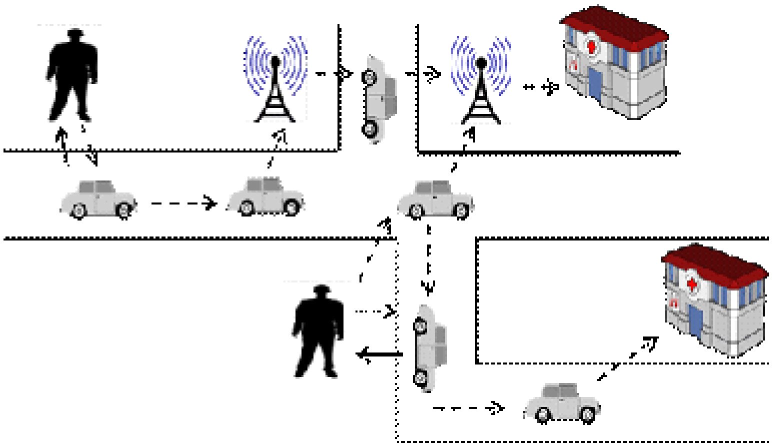

Fig. 1. Data Dissemination Scenario from patients to hospitals via Vehicles

When a neighboring vehicle receives the message, it enables the priority queue within it. Each vehicle upon receiving the emergency messages enables its priority queue. The queue space are allocated to the message based on the amount of data that has been transmitted over the particular link and these are queues are independent of a single link. Prior to transmitting data to the neighboring vehicle the sender encodes the medical data in order to achieve efficient data transmission. In order to encode the message the sender generates a of non-redundant block bits for each transmission, probably a prime series. It then chooses a random sequence of bits from the generated blocks and encodes it with the active frequency at the instant and the medical data using a polynomial function. During encoding process empty bits (null bits) are attached with the frequency bits in order to identify the occurrence of any error. Fig 2 illustrates the steps in encoding a message. While decoding the message if modification in the null bits that is appended with the frequency bits has been notified then it indicates that an error has occurred during transmission.

During the transmission if a hidden terminal problem (that is if vehicles are out of visibility of each other) occurs the transmission between the vehicles is enabled by means of handoff information from the RSU (road side unit). Each RSU periodically broadcasts the handoff information with the other RSU units. Each vehicle entering a region generally registers with the RSU and thus RSU contains information about all the vehicles that are within its communication range. The relay vehicles utilizes multi-hop model to avoid the congestion of data on every transmission and transmit the emergency data rapidly to the destination. An advantage of the proposed algorithm is that the transmission links are effectively utilized by checking the number of connections that the one-hop neighbors can accept.

Simulation Results

In the proposed approach, the VANET applications are executed using Network Simulator 2 (NS 2). All the vehicles are equipped with radio equipments as per the IEEE 802.11p standard and the communication between each vehicle is

Table 1. Simulation Parameters

Simulation and Network Parameters	
Network Area	2000 x 2000
Protocol	AOMDV
No. of Mobile Nodes	100
Network Topology	Flat Grid
IEEE Standard	802.11p
Broadcasting Range	630mts
Application Type	Cbr/ FTP
Application rate	1.0mb
No. of Packets	1500
Simulation Time	30s
Threshold Time	24s
Bandwidth	10Mbps

Encoding Procedure

$b(x) \leftarrow$ generated bit blocks

$f(x) \leftarrow$ active frequency

$m(x) \leftarrow$ message to be transmitted

1. Note the frequency of the current transmission, represent the transmission frequency in binary format and append it with null bits.
2. Represent the frequency f(x) in polynomial format that is associate a increasing power of x with each input bit string i.e., (ax^n)
3. Represent b(x) also in polynomial format.
4. Represent the m(x) in polynomial format.
5. Multiply b(x) with both m(x) and f(x) that is

$$a(x) \leftarrow m(x).b(x)$$
$$b(x) \leftarrow f(x).b(x)$$

6. Combine a(x) and b(x) to form the final transmission message

$$T(x) \leftarrow a(x) + b(x)$$

Fig. 2. Message Encoding Procedure

achieved using CBR traffic and file transfer protocol (FTP). In the proposed scenario AOMDV protocol is used to perform routing operations and each simulation are carried out for a period of 10 seconds. The bandwidth of each link is assumed to be 10 Mbps. The configuration parameters of our simulation environment are illustrated in table 1.

The performance of the proposed approach is analyzed in terms of dissemination time, loss percentage, restoration probability and the response time and is compared with the existing LT-code (LTC) approach. The LTC based approach generates a block and chooses a single bit of value from the generated block. This chosen value is then XORed with the data block which then transmitted to the final destination. At the destination the encoded data is XORed with the source that is used to encode the data to obtain the original data.

Fig 3 shows the average dissemination time taken by the message to reach the destination. The time taken by the message to reach the destination by the proposed sequence based data dissemination is about 0.79 ms (milliseconds) while it takes about 0.845 ms by the LTC approach. Thus it can be shown that the dissemination time of SDD is 19-23 % less when compared to the LTC approach. If the dissemination time is less the data handling capacity increases. But when the number of vehicles increases the dissemination time also increases since the packet has to pass number of vehicles in order to reach the destination.

Fig 4 data loss incurred by the both SDD and the LTC approach. The data loss percentage in SDD is only about 16 % and the loss percentage in LTC is about 22%. The average data loss percentage in case of SDD is 9-12 % less compared to the loss percentage of LTC approach. The packet loss may be due to interference or if the connection between the vehicles is lost. It can be seen in the graph that if the number of vehicles increases the loss percentage also increases. When the number of vehicles increases the congestion in the network increases which results in the ultimate packet loss.

Fig 5 shows the time taken by SDD and LTC in responding to a request. The time to taken to respond to 20 request in case of LTC is about 0.14 ms and the time taken by the SDD for responding to same 20 request is only about 0.11 ms. The average response time in SDD approach is 24 % less than the LTC approach. The response time indicates the time taken for servicing a request and as the number of vehicle increases the number request increases. Since the SDD approach is based on one hop neighbor approach the time taken for servicing a single hop neighbor is basically low. The graph shows that for increasing number of request the response time also increases.

The restoration probability achieved in case of both LTC and SDD is shown in fig 6. The restoration probability is the likelihood of getting the actual message after performing decoding. For example if a 10 bit block data is encoded and transmitted, the restoration probability is 100 if the

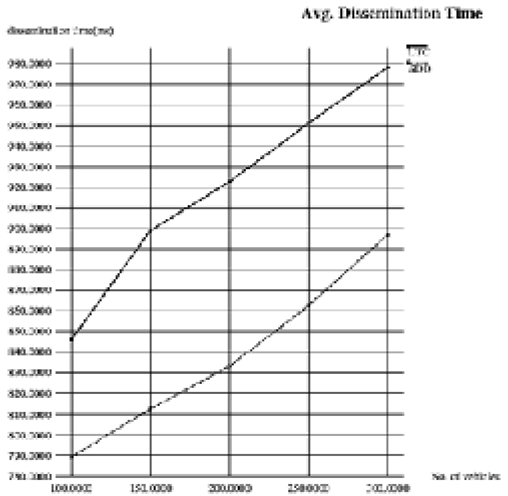

Fig. 3. Average Dissemination Time

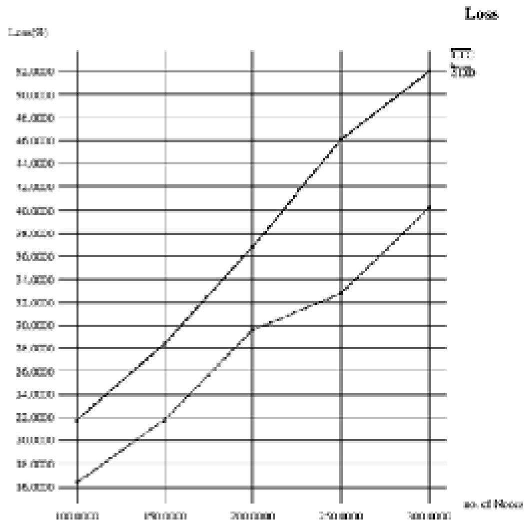

Fig. 4. Data Loss Percentage

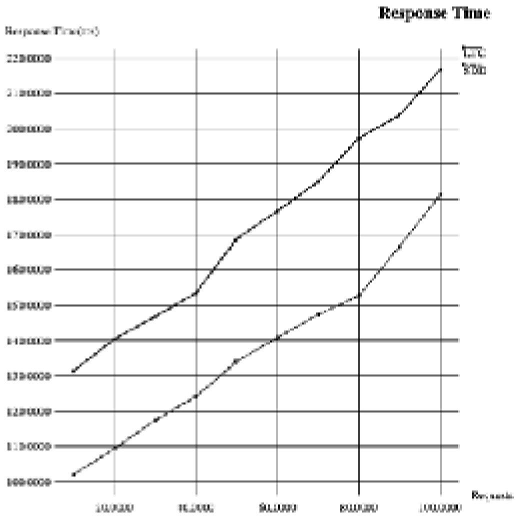

Fig. 5. Response Time

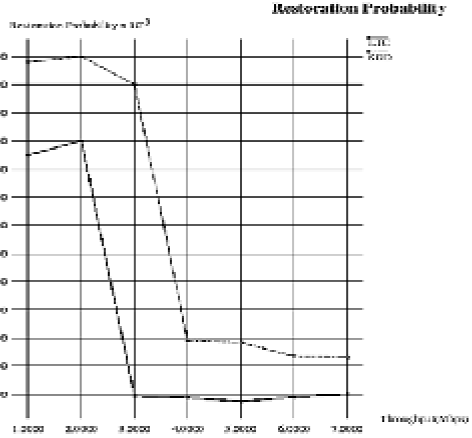

Fig. 6. Restoration Probability

entire 10 bit block is correctly decoded. The restoration probability of SDD is 0.91 while it is 0.875 in case of LTC. The average restoration probability of SDD is about 0.245 less when compared to the LTC approach. It is shown that the restoration probability is slightly decreased as the throughput increases.

CONCLUSION

With the advent of the VANET technology, the physician at the medical center can be aware of the patients' locations and analyze the health information of the patients. Thus in this paper, bio medical information using VANET technology has been exploited to collect data from the patients and transmit it to the final destination. Here, a hop scheduled data dissemination algorithm has been proposed for medical data transmission. Prior to transmission, the medical data are encoded with transmission frequency using polynomial function to allow efficient transmission. Simulations are carried out to analyze the performance of the proposed approach. The results indicate that the proposed approach outperform LT-code based approach in terms of dissemination time, loss percentage, response time and restoration probability.

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