# Modify AODV Routing Protocol to Improve Motorway Surveillance System Performance

**L. A. Hassnawi[1], R.B Ahmad[2], Abid Yahya[3]**
**School of Computer and Communication Engineering, University Malaysia Perlis, Malaysia**
**02000, Kuala Perlis - MALAYSIA**

**Abstract**

This paper presents an algorithm to modify the Ad Hoc On-Demand Distance Vector (AODV) routing protocol in order to improve the routing performance in motorway surveillance systems. The proposed protocol has all the characteristics of the original AODV routing protocol since it follows all the steps of the route discovery and route maintenance mechanism of the original AODV routing protocol. The Modified AODV (MAODV) is different from the original AODV protocol in that it modifies the original AODV to reduce the length of the path of routing messages (RERR and RREQ) when link breakage occurs. In the new protocol, one of the cameras (stationary nodes) which belong to the old route is pushed to start the process of rediscovering a new path to the unreachable destination instead of the source node. The modification of AODV reduces the protocol overhead, packet losses, and packet transmission time delays. It has been observed from the results that the MAODV protocol outperforms the original AODV.

***Keywords:*** *AODV, Link Breakage, Packet Loss, Surveillance System, Throughput.*

## 1. Introduction

The motorway surveillance system is one of the important technologies used today. It is used to collect information about traffic conditions such as density, accidents and other useful information. In traditional motorway surveillance systems, the system is designed to send the information to a predetermined location (the "Base Station") for processing and monitoring, or else to gateway points and then these gateway points send all the information to the Base Station [1]. The traditional system does not provide effective access to the surveillance system network for the users of the motorway, for example, not all vehicles have access to the base station or the gateway points because the distance between the vehicle and the gateway is too far, thus the need to have more base stations. Our previous work [2] proposed and evaluated the design of a new motorway surveillance system. The proposed system has a new image acquisition technique to enable the motorway user (the drivers of vehicles) to access this system by requesting data from any camera while driving the vehicle, in order to view the road conditions without using any additional infrastructure or centralized administration. The new system consists of a large number of IP cameras. These cameras are distributed along the motorway and connected with each other to form a new type of network which we have called the Wireless Ad Hoc Camera Network (WAHCN) [2]. The operation of WAHCN is based on the operations of the mobile Ad Hoc networks (MANETs); therefore, it inherits all the features of the MANETs. The nodes within the WAHCN are divided into two types: mobile nodes (vehicles) and stationary nodes (cameras).

In the WAHCN, there is no fixed topology due to the mobility of vehicles. The mobility factor leads to link breakage and path loss [3]. Frequent link breakage causes packet loss which degrades network performance. The motorway surveillance system can tolerate a certain level of packet losses in order to get good image quality. The lost packets must be retransmitted in order to keep image quality. The penalty for retransmission of lost packets due to link breakage is increased delay. Delays will degrade the performance of the WAHCN.

Therefore, the main objective of this paper is to modify the operation of the AODV routing protocol through decreasing the path of RERR and RREQ in order to improve the performance of the motorway surveillance system network (WAHCN).

When the path between the source and destination disconnects due to vehicle mobility or for any other reason, the AODV routing protocol [4] tries to repair the broken path by initiating and sending an RERR message to the source node to inform the source and all the intermediate nodes that the destination via this path is unreachable. When the source node receives the RERR, if it still has data that must be sent to the unreachable destination, it starts to rediscover the route to the unreachable destination by flooding the network with new RREQ messages in order to locate a new route to the destination. The processes of sending the RERR and RREQ control messages to maintain the broken path increase the protocol overhead, packet transmission time delay, and the number of packets lost. These problems degrade the performance of WAHCN of the motorway surveillance system.

The main contribution of this paper is modifying the AODV routing protocol through decreasing the path length of RERR and RREQ messages by making one of the stationary nodes which belong to the broken link to start the process of repairing the broken path instead of

the source node. The modified AODV decreases the protocol overhead which leads to improve the performance of WAHCN of the motorway surveillance system.
The remaining paper is organized as follows: Section 2 presents the related work, Section 3 describes the types of routing protocol used in mobile Ad Hoc networks, Section 4 describes the proposed protocol, Section 5 presents the simulation scenario and model design, Section 6 presents the results and discussion. Finally, Section 7 concludes the paper.

## 2. Related work

Many studies are undertaken to analyze and improve the performance of the Ad Hoc on- demand Distance Vector Protocol (AODV). Rakesh et al. [5] extended AODV routing protocol for Ad Hoc networks, which typically is well-suited to resolve the realistic model problems. The author assumes that the network consists of static nodes since most of the users access the network from their offices or from their homes. These nodes do not move from one place to another, and any changes in the network can be stored in these static nodes in order to provide better performance. Venetis et al. [6] presented a scheme for RREQ message forwarding for AODV that reduces routing overheads. This has been called AODV_EXT. Ahed et al. [7] presented a local recovery protocol called Bypass-AODV. It uses cross-layer MAC-notification to identify the mobility-related link breaks, and then sets up a bypass between the broken-link end nodes via an alternative node. Chonggun et al. [8] proposed a reverse AODV which tries multiple route replies. The extended AODV is called reverse AODV (R-AODV) which is a novel aspect compared to other on-demand routing protocols on Ad Hoc networks.

## 3. Mobile Ad Hoc Routing Protocol

According to the mode of operation of the routing protocol, the Mobile Ad Hoc Network (MANET) routing protocols can be divided into two types: reactive routing and proactive routing. Reactive routing protocols are also called "on-demand" routing protocols. They establish the route only when it is required; they do not update their routing information frequently and will not maintain the network topology information. Reactive routing protocols (e.g. AODV and DSR) use the connection establishment process for communication [9].
A proactive routing protocol (e.g. OLSR and DSDV) is a table-driven protocol. It maintains the routing information of all the participating nodes and updates their routing information frequently irrespective of the routing requests. These protocols proactively transmit control messages to all the nodes and update their routing information even if there is no actual routing request.

### 3.1 Ad Hoc on Demand Distance Vector (AODV) Routing Protocol

The Ad Hoc On-Demand Distance Vector (AODV) Protocol is an IP routing protocol that allows users to find and maintain routes to other users in the network. AODV is on-demand or reactive since the routes are established only when needed. The routing decisions are made using distance vectors, i.e. distances measured in hops to all available routers. The protocol supports unicast, broadcast, and multicast. The version of AODV described below is based on the RFC draft standard [4].
Each node maintains a sequence number which saves a time stamp, and a routing table which contains routes to destinations. Sequence numbers are used to determine the freshness of routes (the higher the number, the fresher the route, and consequently, the older one can be discarded). The routing table consists of a number of entries; each table entry contains the address of the next hop (next node to destination), a hop count (number of hops to the destination), and a destination sequence number. Since this is an on-demand distance vector scheme, routers maintain distances to those destinations only in case that they need to contact or relay information to them. Each active route is associated with a lifetime stored in the table; after this time has passed, route timeout is triggered, and the route is marked as invalid and later on removed. AODV can deal with any kind of mobility rates and a variety of data traffic. AODV uses two main mechanisms. These are as follows:

- Route Discovery mechanism.
- Route Maintenance mechanism.

#### 3.1.1 Route Discovery Mechanism in AODV

If a sender (source node) needs a route to a destination, it broadcasts a ROUTE REQUEST (RREQ) message. Every node also maintains a broadcast id which, when taken together with the originator's IP address, uniquely identifies a RREQ. Every time a sender issues a RREQ, it adds incrementally to its broadcast id and sequence number by one. The sender buffers this RREQ for PATH DISCOVERY TIME (PDT) so that it does not reprocess it when its neighbors send it back. The sender then waits, so-called NET TRAVERSAL TIME (NETT), for a ROUTE REPLY (RREP). If a RREP is not received within this time, the sender will rebroadcast another RREQ, up to a certain number of RREQ TRIES times. With each additional attempt, the waiting time (NETT) is doubled. When a node receives a RREQ message it has not seen before, it sets up a reverse route back to the node where the RREQ came from. This reverse route has a lifetime value of ACTIVE ROUTE TIMEOUT (ART). The reverse route entry is stored along with the information about the requested destination address. If the node that receives this message does not have a route to the destination, it rebroadcasts the RREQ. Each node keeps track of the number of hops the message has made, as well as which node has sent it the broadcast RREQ. If nodes receive a RREQ which they have already processed, they discard the RREQ and do not forward it. If a node has a route to the destination, it then replies by unicast with a RREP back to the node it received the request from. The reply is sent back to the sender via the reverse route set by the RREQ. The RREP propagates back to the source; nodes set up forward pointers to the destination. Once the source node receives the RREP, the route has been established and the source starts to send data packets to the destination.

#### 3.1.2 Route Maintenance Mechanism in AODV

As mentioned in [4], the role of route maintenance is to provide feedback to the sender in case a link breakage happens, to allow the route to be modified or re-discovered. A route can stop working simply because one of the mobile nodes has moved. If a source node moves, then it must rediscover a new route. If an intermediate node moves, it must inform all its neighbors that may have needed to use it for a hop. A message is forwarded to all the other hops and the old route is deleted. The source node must then re-discover a new route. One proposed way for a node to keep track of its neighbors is by using HELLO messages. These are periodically sent to detect link failures. Upon receiving notification of a broken link, the source node can restart the rediscovery process. If there is a link breakage, a ROUTE ERROR (RERR) message can be broadcast on the network. Any host that receives the RERR invalidates the route and then rebroadcasts the error messages with the unreachable destination information to all nodes in the network.

### 3.2 Drawback of Original AODV

One important drawback of the original AODV design is that a large number of control packets are generated when a link breakage occurs. These control packets increase the congestion in the active route. Consequently the overhead in the bandwidth increases with the increase in the number of control packets which leads to increasing the packet loss and packet transmission time delay.

## 4. The Modified AODV Protocol

The Modified AODV (MAODV) differs from the original AODV protocol through modifying the original AODV to shorten the path for RERR message when link breakage is happened. MAODV pushes one of the cameras (a stationary node) which belongs to the old route to discard the received RERR message from the predecessor node to ensure it does not reach the source node. It then starts the process of generating a new RREQ message to repair the broken link. In the original AODV, repairs would be initiated from the source node. In the MAODV, a stationary node near the breakage initiates repairs instead of the source node.

MAODV modifies the original design of AODV. It is based on a system in which any stationary node which belongs to the broken route (old route) is enabled to rediscover a new route from its position to the unreachable destination. This is feasible because the path from the source node to any stationary node which belongs to the old route (broken path) does not change and may still valid. A state flag is assigned to each node in order to differentiate if the node is mobile or stationary; this flag is set to zero (stationary node) for all cameras nodes and set to one for any mobile node.

### 4.1 The Operation of the MAODV Protocol

After the route discovery process is finished by the MAODV, as in the original AODV protocol, the route between the source and a destination is established. Then the source starts sending the data to the destination, hop by hop. If a link between any two nodes is broken for any reason, the predecessor node of the broken link initiates and sends the ROUTE-ERR message towards the source node. This process is the same in the MAODV as in the original AODV.

In the new modifications for the MAODV, any intermediate node that receives the generated RERR message, checks its state flag. If the intermediate node is stationary and if it belongs to the old route (the broken route), then it starts the processes to rediscover a new route from its position to the currently unreachable destination, instead of the source node. The stationary nodes (cameras) contain route information in their routing tables from the source node to their positions. This information does not change because all camera nodes are stationary and distributed in line topology. Therefore, there is no need to send the ROUTE-ERR message to the source node in order to rediscover a new path to the unreachable destination.

The buffer of the MAC layer on each stationary camera node is used to store the data packets received form the source node after the declaration of the broken link in order to decrease the packet loss. After repair of the broken path, the routing table's entry for the path to the destination is modified according to the new route. The camera node that performs the process of rediscovering a new path to an unreachable destination starts to send the stored packets in its buffer to the destination via the new path. From this point on, then the MAODV continues to work in the same way as the original AODV.

### 4.2 Algorithm of the Proposed Protocol

The proposed protocol (MAODV) follows these steps to rediscover and modify the broken path:

1. Any node which senses that the link with the next hop on the active route is broken, initiates and

sends the RERR message to the source node, in the same way as in the original AODV.

2. Any intermediate node which receives the RERR message, then checks its state flag; if the node is mobile, it then forwards the RERR message to the next hop towards the source.

3. If the intermediate node is stationary, then it checks if it is a part of an old route (broken path). If it is not, it forwards the RERR and goes to step 2.

4. In the case that the intermediate node is a part of the old route (and has an entry for a path to the unreachable destination in its routing table), it must perform the steps below:

   - Discard the RERR message.
   - Stop sending the data to the next node.
   - Save the received packets from the source node.
   - Increment the destination's sequence number.
   - Initiate an RREQ message and broadcast it to all neighbors.
   - Wait to receive the RREP from the destination.

5. When the initiator of the RREQ has received the RREP from the destination or from any node which has a route to the destination, it must perform the steps below:

   - Modify the routing table's entry for the path to the destination according to the new route.
   - Start sending the saved data.

6. MAODV continues to work the same as the original AODV from this step onwards.

All the rules of the original AODV apply to the MAODV since the MAODV just decreases the path of the RERR. The one major difference is that the MAODV pushes one of the camera nodes (a stationary node which is part of the old route) to rediscover the broken path instead of the source node. Figure 2 shows the flowchart of maintaining and repairing the broken link using MAODV protocol.

## 4.3 Mathematical Representation of the Proposed Protocol

In order to simplify the mathematical representation of the MAODV routing protocol, the following assumptions will be taken:

1. Each camera has an identification number within the surveillance system network. The identification number starts from "0" to the total number of cameras within the surveillance system network. The "0" identification number is given to the first camera and "1" is given to the second camera and so on. Such as the camera $n_{i-1}$ comes before camera $n_i$ within the network of the surveillance system as shown in Figure 1.

2. The vehicle is moving toward the source node.

Table 1 describes the symbols used in the mathematical representation.

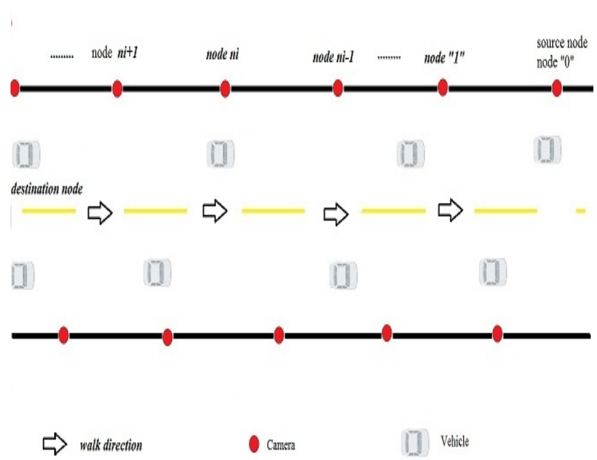



Figure 1: Motorway Surveillance System Scenario

Table 1: Description of each symbol used in the mathematical representation

| ***Symbol name*** | ***Description*** |
|---|---|
| N | Total number of nodes within the network |
| n | Current node index |
| C(n) | Connectivity index parameter of node n with its Neighbors |
| S(n) | Stationary index parameter for node n |

| | |
|---|---|
| P | Path of n nodes index parameter |
| D(n) | Data at node n (data or control messages) |
| X | Cameras nodes index |
| PKn | Packet at node n |
| Jn | Total number of packets at node n on specific time |
| Yn | Total number of neighbors of node n |
| Des(seq no) | Destination sequence number (this parameter belong to AODV) |

Then

$$C(n) = \begin{cases} 0 & \forall \quad N \notin P \\ 1 & \forall \quad N \in P \end{cases} \quad (1)$$

And

$$S(n) = \begin{cases} 0 & \forall\ N \notin X \\ 1 & \forall\ N \in X \end{cases} \quad (2)$$

if $C(n_i) == 1$ Then

$$D(n_i) \xrightarrow{\text{send to}} D(n_{i+1}) \quad (3)$$

Else

$D(n_i) \equiv \text{RERR}$ Generate RERR at node $n_i$
Send RERR back toword the source node.

$$D(n_i) \xrightarrow{\text{send RERR to}} D(n_{i-1})$$

if $\left((n_{i-1}) \in X \ \&\& \ (n_{i-1}) \in P\right)$ Then
$D(n_{i-1}) \equiv 0$ Discard RERR

All the packets received from source node must be saved in the stack (St) of node$(n_{i-1})$

Repeat for $(i = 0,1,2, \dots, j_n)$
$St[i] = PK_i$ (4)

then the destination sequence number must be increased.

$$\text{Des(seq no)} = \text{Des(seq no)} + 1$$

Generate RREQ message at node$(n_{i-1})$instead of source node.

$$D(n_{i-1}) \equiv \text{RREQ} \quad (5)$$

Broadcast RREQ message to all neighbors of node ($n_i$-1)

$$D(n_{i-1}) \xrightarrow{\text{Broadcast RREQ}} D(n_{i-1+z}) \ \forall \ N > n_{i-1} \ \text{ for } z = 1,2,3, \dots, Y_n \quad (6)$$

As broadcasting packets (like RREQ) are not acknowledged, the broadcaster of these packets has to wait some time for the RREP (RREP time out latency). If no RREP is received within a certain time it considers that either the RREQ has not been received by the destination node or collision has occurred and retransmitting RREQ. The Time To Live (TTL) of RREQ message starts with MAX_HISTORY + TTL_INCREMENT (MAX_HISTORY is maximum TTL that used and found in the routing table before the route breakage with the same destination). If no RREP is received then the RREQ will be repeated with TTL = last_TTL + TTL_INCREMENT [4]. This procedure is done until maximum RREQ retrial is finished. Therefore the algorithm pushes the node which is the generator of RREQ to wait the RREP control message as shown below.

It is noted here that "H" is running sequence pointer

H:
Wait for
$T = MAX\_HIS + TTL\_INCR.$ (7)

if$(n_{i-1}) \xleftarrow{\text{Received RREP}}$ RREP then

Modify the routing table at node$(n_{i-1})$

Then send all the packets saved on the stack of node $(n_{i-1})$to the Destination via new route.

else

$TTL = last\_TTL + TTL\_INCR.$ (8)

Goto H

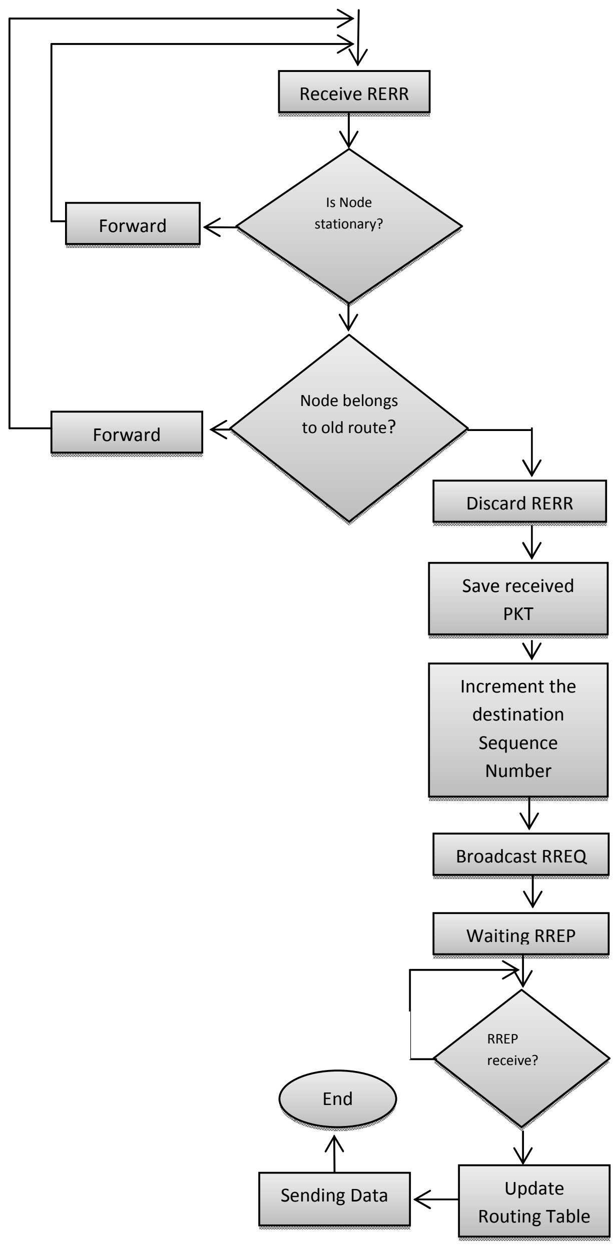



Figure 2: Flowchart of Maintaining and repairing the broken link in Modified AODV Routing Protocol

## 5. Simulation Scenario

OMNeT++ ver. 4.1, [10] is used to model the motorway surveillance system scenario. The designed model with an extensive set of parameters is performed to evaluate and analyze the performance of the Modified AODV (MAODV) on the WAHCN of the motorway surveillance system as shown in Figure 1. Table 2, shows the parameters setup.

Table 2: Parameters setup

| ***Parameter name*** | ***Value*** |
|---|---|
| Playground | 5000 m * 100 m |
| Number of camera nodes | 40 |
| Distance between camera nodes | 250 m |
| Packet size | 0.5KB |
| Packet rate | 20 packet/s |
| Simulation time | 500 s |
| Routing protocol | AODV,MAODV |
| MAC protocol | 802.11g |
| Radio bit rate | 54 Mbps |
| Vehicle speed | 10,20, 30, 40 and 50 meter/second |

### 5.1 MAODV Model Setup

The evaluation of the MAODV is done on the motorway scenario with the following model specifications:

- The simulation scenario is a 5 km straight motorway section with two lanes in one direction.
- 40 camera nodes distributed along both sides of the motorway in a line topology with 250 meter separated between each two cameras.
- Three vehicles distributed on the lanes of the motorway and moves in freeway mobility pattern. The distance between each two vehicle is 50m.
- The vehicles' speeds are distributed between 36 km/h, as the minimum speed and 150 km/h as the maximum speeds.
- The size of data packet is 512Byte.
- The value of data rate is selected 20 packets / second.
- All the cameras using UDP traffic sources.
- Data transfer rate is 54 Mbps.
- OMNET++ default parameters.
- All experiments tested for 500 seconds simulation time.
- All vehicles move according to the freeway (linear) mobility pattern.
- All the vehicle moves toward the sources of data.

### 5.2 Performance metrics

The metrics that are selected to evaluate the MAODV performance are:

- Throughput – represents the average rate of successful packet delivery per unit time over a communication channel [11].
- Packet transmission ratio (PTR) - represents the ratio between the number of packets received by the receiver and the number of packets sent by the source [12].
- Packet Loss- represents the number of lost packets.
- Average packet transmission time (delay) - which is the difference between the time when packet is sent by the camera node and the time when the packet arrived at the vehicle node.
- Protocol overhead- represents Total number of bytes and packets used for routing during the simulation.

## 6. Results and Discussion

Two types of experiments were carried out to evaluate the impact of vehicle speed variations and the number of data sources on the performance of the MAODV routing protocols.

### 6.1 Using A Single Source of Data

Figure 3 (a-to-e) shows the performance of the MAODV as compared to the original AODV under varying vehicle speeds in motorway scenario for a single source of data. It has been observed from the results that there are improvements in the MAODV performance with respect to network throughput, number of packets lost, packet transmission ratio, average transmission time, and protocol overhead. The reason for this improvement is due to the reduction of the protocol control messages, because the MAODV reduces the path of the ROUTE-ERR message, and it does not need to send the RERR message to the source which in turn reduces the time that is required to rediscover the broken path. Moreover, the rediscovery of the broken link is performed by one of the camera nodes which is stationary and belongs to the old route (broken route), instead of the source node, and this reduces the area which is flooded by the RREQ message, which means decreasing the protocol overhead. Figure 3 (f) shows the packet transmission difference ratio between the MAODV and AODV. It can be seen from Figure 3 (f) that the Packet Transmission difference ratio increases with an increase in the vehicle speed until the vehicle speed exceeds 34mps, then the performance of the MAODV is nearly started to be fixed despite an increase in speed of the vehicle.

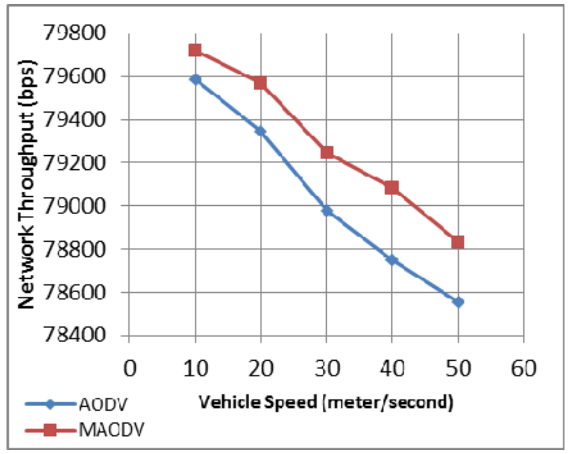



Fig. 3(a) Network throughput vs. Vehicle speed using single source of data

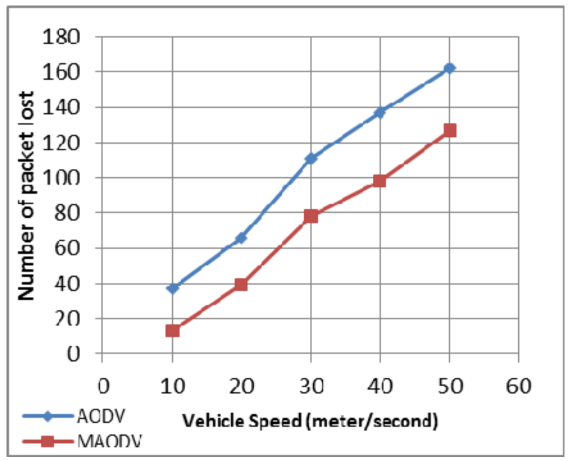



Fig. 3(b) Number of packets lost vs. Vehicle speed using single source of data

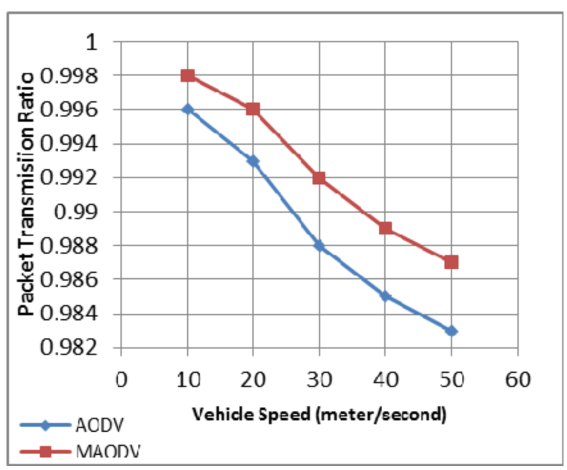
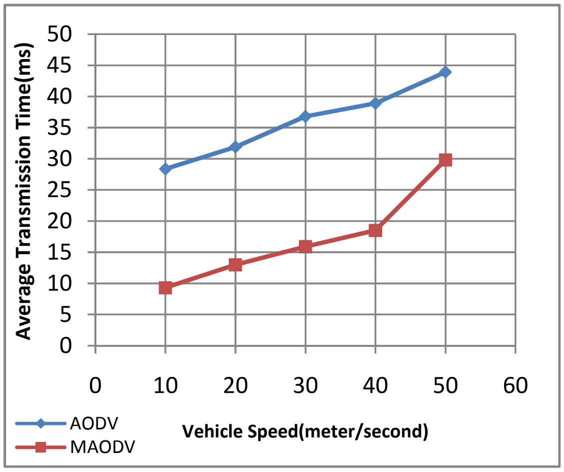



Fig. 3(c) Packet transmission ratio vs. Vehicle speed using single source of data



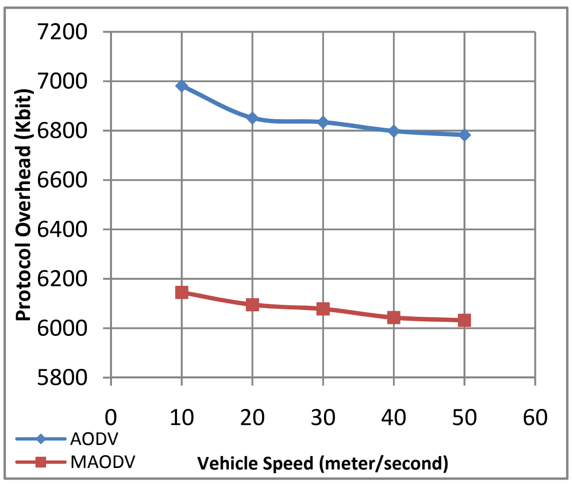




Fig. 3(e) Protocol overhead vs. Vehicle speed using single source of data

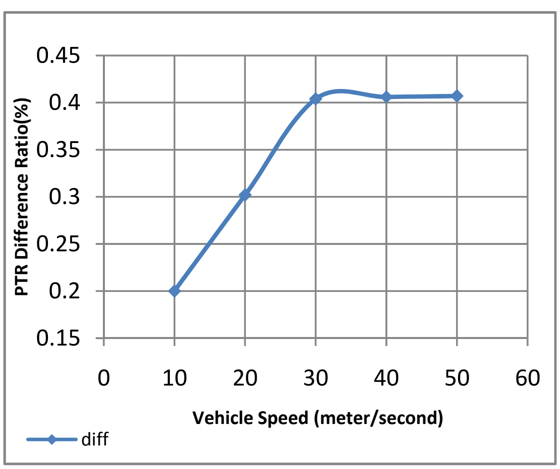



Fig. 3(f) Packet transmission difference ratio between both protocols vs. Vehicle speed using single source of data

## 6.2 Using Multi Sources of Data

Figures 4 (a-to-e), shows the performance of the MAODV as compared to the original AODV under varying vehicle speeds in motorway scenarios for three sources. It has been observed from the results that there are improvements in the MAODV performance with respect to network throughput, number of packets lost, packet transmission ratio, average transmission time, and protocol overhead. The reason for this improvement is due to the reduction of the protocol control messages, because the MAODV reduces the path of the ROUTE-ERR message, and it does not need to send the RERR message to the source. This modification leads to reduction of the packet transmission time delay. Moreover, the rediscovery of the broken link is performed by one of the camera nodes which is stationary and belong to the old route (broken route), instead of the source node, and this reduces the area which is flooded by the RREQ message, which means a decrease of the protocol overhead. Decreasing protocol overhead leads to a reduction of the congestion and reduces the number of packets lost. The number of lost packets is decreased when using the MAODV because any stationary node (camera) which has received an RERR message from the predecessor node of the broken link starts to save the received packets in its buffer instead of dropping these packets. This will reduce the packets lost.
Figure 4 (f) shows the packet transmission difference ratio between MAODV and original AODV. It has been observed from Figure 4 (f) that the difference between MAODV and AODV increases with an increase of the vehicle speed. Increasing the vehicle speed will increase the probability of link breakage which reduces the duration of the path, as shown with the equations below:

$$Lb = \rho * \frac{Vh}{R} \qquad (9)$$

Where
Lb: the probability of link breakage.
ρ: constant of the proportionality.
V: vehicle velocity.
h: number of hops on the path.
R: transmission range.

$$PD = \frac{1}{Lb} \qquad (10)$$

From equation 9 and 10

$$PD = \frac{R}{\rho Vh} \qquad (11)$$

Equation 11 shows that the path duration is inversely proportional to the vehicle speed. This can be interpreted to mean that the probability of link breakage increases with the increase of the vehicle speed. When a link within the path is broken due to increasing the vehicle speed, the original AODV and the MAODV will both generate the control messages (RERR and RREQ) in order to maintain and rediscover the broken link. The control messages generated due to link breakage in MAODV are fewer than the control messages generated in the original AODV, according to the modification performed in MAODV as mentioned before. Therefore, the Packet Transmission difference ratio between them starts to increase with an increase to the vehicle speed. Figure 4 (f) also shows that the difference between both protocols starts to decrease when the vehicle speed exceeds 35mps which means that the operation of both protocols starts to be similar after the vehicle speed exceeds 35mps. This means that there is a drawback of the MAODV which is that the performance of the MAODV is nearly similar to AODV at high vehicle speeds. The packet transmission difference ratio between both protocols is calculated as:

$$\text{Difference Ratio} = \frac{\text{PTR of MAODV} - \text{PTR of AODV}}{\text{PTR of AODV}} * 100\%$$

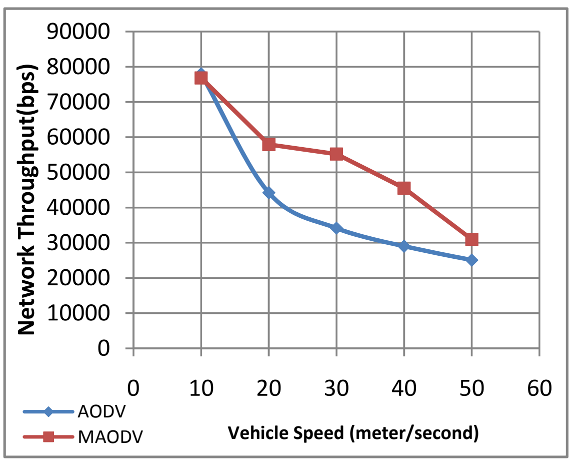



Fig. 4(a) Network throughput vs. Vehicle speed using Multi source of data

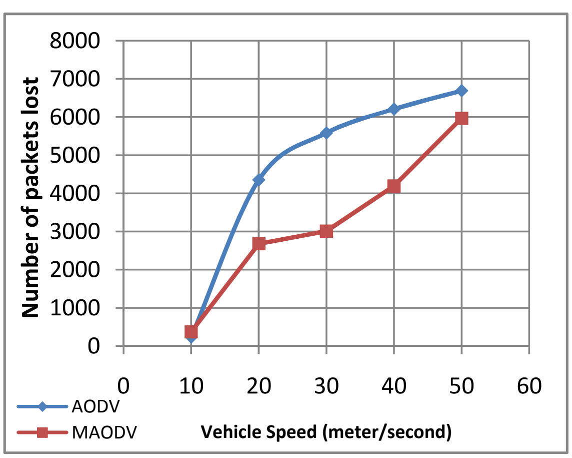



Fig. 4(b) Number of packets lost vs. Vehicle speed using Multi source of data

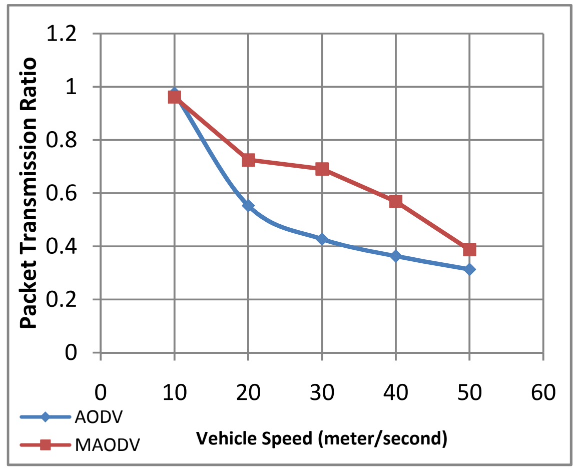



Fig. 4(c) Packet transmission ratio vs. Vehicle speed using Multi source of data

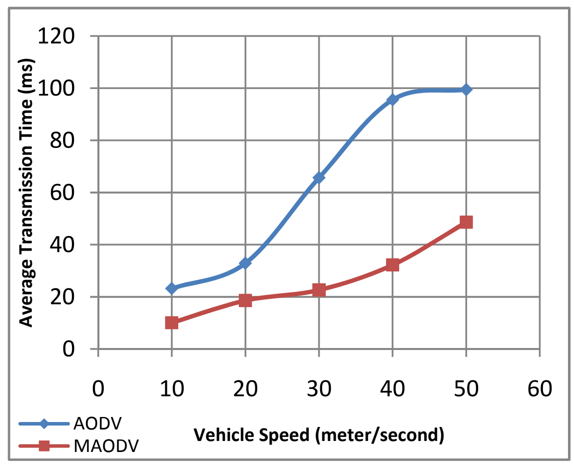



Fig. 4(d) Average transmission time delay vs. Vehicle speed using Multi source of data

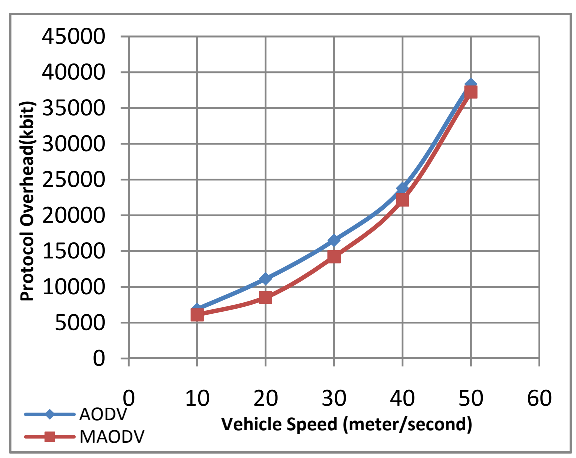



Fig. 4(e) Protocol overhead vs. Vehicle speed using Multi source of data

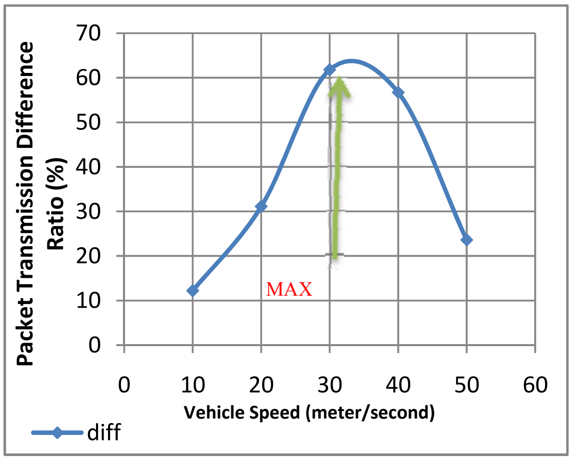



Fig. 4(f) Packet transmission difference ratio between both protocols vs. Vehicle speed using Multi source of data

## 7. Conclusion

This paper presents and evaluates an algorithm which modifies the operation of the AODV routing protocol in order to improve the routing performance in motorway surveillance systems. The modified protocol is shown to have improved the routing performance by shortening the path length of RERR and RREQ control messages which leads to reduction in protocol overhead. The modification is made by using stationary nodes which belong to a broken path to rediscover and modify the broken link. The results of experiments show that the MAODV outperformed the AODV when using single and multi-sources of data at variable vehicle speeds. It can be concluded from the results of using multi sources of data, that the average MAODV overhead is less by 11.72% than the original AODV. Moreover, the number of packets lost decreased by 31.9% and packet transmission time was reduced by 42.28% over the original AODV. In case of single source of data, the performance of the MAODV protocol increased with an increase in vehicle speed until the vehicle speed exceeds 34mps, then performance of the MAODV is nearly started to be fixed despite an increase in speed of the vehicle. In case of using multi source of data the difference between both protocols starts to decrease when the vehicle speed exceeds 35mps which means that the operation of both protocols starts to be similar after the vehicle speed exceeds 35meter/second.

## References

[1] W.-T. Chen, P.-Y. Chen, W.-S. Lee and C.-F. Huang, “Design and implementation of a real time video surveillance system with wireless sensor networks,” in Vehicular Technology Conference, 2008. VTC Spring 2008. IEEE, May 2008, pp. 218–222.

[2] L. A. Hassnawi, R.B Ahmad, Abid Yahya, M. Elshaikh, Ali A. A. Al-Rawi, Z. G. Ali, S. A. Aljunid, ”Measurement Study on the End-To-End Data Transmission in Motorways Surveillance System Using Wireless Ad Hoc Camera Networks (WAHCN)”, International Conference on Engineering Industry, Korea 2011.

[3] L. Yenliang, L. Huier, G. Yajuan, and A. Helmy, "Towards mobility-rich analysis in ad hoc networks using contraction, expansion and hybrid models," IEEE International Conference on Communications, 2004, vol. 7, pp. 4346 - 4351.

[4] E. M. Belding-Royer, I. D. Chakeres, and C. E. Perkins,”Ad hoc On-Demand DistanceVector (AODV) Routing”, Internet Draft, RFC 3561bis-01, `http://moment.cs.ucsb.edu/pub/draft-perkins-manet-aodvbis-02.txt`. Work in progress, July 2004.

[5] Rakesh kumar, Siddharth Kumar, Sumit Pratap Pradhan, Varun Yadav.” Modified route-maintenance in AODV Routing protocol using static nodes in realistic mobility model”,International Journal on Computer Science and Engineering (IJCSE), Vol. 3 No. 4 Apr 2011, ISSN : 0975-3397.

[6]Venetis Kanakaris, David Ndzi, Kyriakos valiadis,” Improving AODV performance using dynamic density driven route request forwarding”, Department of Electronic and Computer Engineering, University Portsmouth, Anglesea Road, Portsmouth, PO13DJ,United Kingdom.

[7]Ahed M. Alshanyour, Uthman Baroudi,” Improving Performance of Ad Hoc On-Demand Distance Vector (AODV) Routing Protocol in Wireless Ad Hoc Networks”, Ambi-sys 2008,February 11-14, 2008, Quebec, Canada,. © 2008 ICST 978-963-9799-16-5.

[8] Chonggun Kim, Elmurod Talipov, and Byoungchul Ahn,” A Reverse AODV Routing Protocol in Ad Hoc Mobile Networks”, IFIP International Federation for InformationProcessing 2006,, LNCS 4097, pp. 522 – 531,2006.

[9] L. Abusalah, A. Khokhar, and M. Guizani, “A survey of Secure Mobile Ad Hoc Routing Protocols” in Proc. IEEE, 2008, pp. 78-93.

[10] Varga A. “Using the OMNET++ discrete event simulation system” European Simulation multi conference (ESM’01) Prague, Czech Republic,2001,june.

[11]Cisconet, “Internet Speed Issue - Bandwidth VS. Throughput.” Novemeber 2009, available online: http://cisconet.com

[12]J. Harri, F. Filali and C. Bonnet, “On Meaningful Parameters for Routing in VANETs Urban Environments under Realistic Mobility Patterns.” 2007 Eurecomm Seminar Series, Sophia-Antipolis, France, 18 January 2007, available online.

L.A. HASSNAWI was born in Iraq. He received the B.Sc. degree in Electrical and Computer Engineering from Military Engineering College, Iraq, in 1993; and the M.Sc. degree in Computer Engineering from University of Technology, Iraq, in 2002. He worked as a lecturer in Al Mansoor University in IRAQ until 2005, and then he worked as a researcher in the Ministry of Science and Technology (MOST), Iraq until 2009. His researches interest in the area of networks design and Routing in wireless networks. He has an experience in networking, communication, and information technology (IT).

He obtained B. Eng. in Electrical & Electronic Engineering from Glasgow University in 1994. He obtained his M.Sc. and PhD in 1995 and 2000 respectively from University of Strathclyde, UK. His research interests are on computer and telecommunication network modeling using discrete event simulators, optical networking & coding and embedded system based on GNU/Linux for vision. He has five (5) years teaching experience in University Sains Malaysia. Since 2004 until now he is working with university Malaysia Perlis (UniMAP). Currently as the Dean at the School of Computer and Communication Engineering and Head of Embedded Computing Research Cluster.

Abid Yahya earned his B.Sc. degree from University of Engineering and Technology, Peshawar, Pakistan in Electrical and Electronic Engineering majoring in telecommunication. Dr. Abid Yahya began his career on a path that is rare among other Researcher executives and earned his M.Sc. and Ph.D. degree in Wireless & Mobile systems, in 2007 and 2010 respectively, from the university Sains Malaysia, Malaysia. Currently he is working at School of Computer and Communication Engineering, university Malaysia Perlis (UniMAP). His professional career outside of academia includes writing for the International Magazines, News Papers as well as a considerable career in freelance journalism. He has applied this combination of practical and academic experience to a variety of consultancies for major corporations.