Performance Comparison of Mobility Techniques In Unmanned Aerial Vehicle (UAV) Based WSN

Shilpa Sharma[1], Anshu Sharma[2], Er. Abhishek Bhagat[3], Er. Robin chadha[4]

[1]Assistant Professor, School of Computer Science and Engineering, LPU, Jalandhar, India
[2]Assistant Professor, School of Computer Science and Engineering, CTITR, Jalandhar, India
3Research Scholar, CTITR, Jalandhar, India
[4]Assistant Professor, School of Computer Science and Engineering, CTITR, Jalandhar, India

Abstract

Unmanned aerial vehicle(UAV) based WSN[4]is designed in areas where human approachability is zero. UAV networks consist of multiple mobile UAV's acting as nodes capable of data gathering, processing and communication also. These vehicles rely on onboard batteries for their operations as well as movement. So efficient mobility models were designed so as to minimize the consumption of battery's voltage. This paper presents the comparison of different mobility techniques [1] in the event driven UAV based Wireless Sensor Network (WSN) on the basis of their energy consumption values as well as node density. OMNET++ 5.5helps us for the designing as well as computation ofUAV wireless sensor network.

Keywords: UAV basedWSN, Energy consumption, Mobility models,Modulation,MIXIM, OMNET ++.

1. Introduction

UAV is a kind of mobile node(Drone) that could be controlled remotely as well as fly separately in their embedded system via software-controlled flight plans, which are working in concurrence with GPS and onboard sensors. In the past, UAVs were generally connected with the various military actions, where initially they had been used for intelligence gathering, anti-aircraft target practice, or as weapons platforms. Now a days, Drones are using in a huge range of applications like, surveillance, traffic monitoring, weather monitoring, drone based photography, agriculture, delivery services and videography. The UAVs plays a significant role in gathering information about the areas which are not suitable with respect to human survival or where human approachability is nearly zero. UAVs can capture information easily from those kinds of areas as they are controlled remotely by human beings and they continuously transmitthe monitored information to the human base stations.

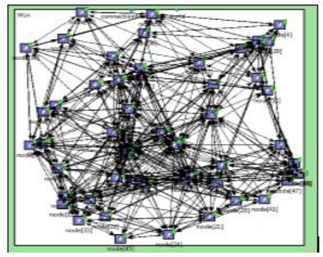

Figure 1: Wireless sensor network

A Typical Unmanned Aerial Vehicle based wireless sensor network (WSN) contains individual mobile nodes whichhelp to interact with their environment by controlling and sensing physical parameters. No doubt, these nodes are deployed in very large number to collect the information as their communication as well as mobility ranges are finitely defined. These nodes need to work together to complete their tasks as a single node is not able to do so and wireless communication enable them to enable this collaboration.

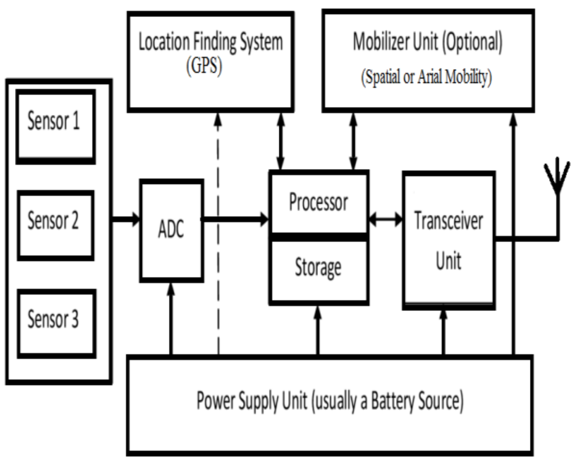

Figure 2: Typical mobile sensor node

The purpose of choosing mobile nodes in place of static node in these kinds of environments is to reduce the load of nodes which are present near the sink terminal. In case of static network, energy of nodes which are present near to base station is continuously draining as these nodes were all time busy in transferring the data sensed by other nodes to the base station. So to remove this problem and to make the network more energy-efficient, the concept of mobility is introduced in the WSNs. With the help of the mobility, the nodes can move in the network and share their responsibility of transmitting data to the base station or sink[6]. With the help of the mobility, the efficiency of sensing an event is also increased. But in addition to this, there is a drawback of mobility that the movement of nodes also consumes energy from the onboard batteries. So to cope up with this drawback there is a need of energy-efficientmobility models.

ISSN: 0971-1260
Vol-22-NO-30 Special Issue-December-2019

OMNET++ 5.5[14] with MIXIM 2.3is used for the designing and computation of energy consumption for different mobility models used in UAV based wireless sensor network. The performance of these models is also checked for variable node density (50,100,150,200).

MIXIM[13] is a modeling framework designed for fixed wireless networksand .it's a user friendly graphical representation of wireless networks in OMNET++.

In Section 2, we have discussed the system architecture. And then we representscenario wiseanalysis with their results in Section 3.At the end, conclusion have been discussed in Section 4.

2. System Architecture

This UAV based network architecture have variable node density of 50,100,150,200 nodesi.e. mobility models were analyzed for increasing node density in the fixed 3D environment of size 500*500*500 m^3. A communication between the sensor nodes and sinknodes is based on IEEE 802.15.4[8] standard. 2.4 GHz frequency band is used in this network because it contain the highest data rate i.e. 250Kbps.The modulation technique used is Minimum Shift Keying.

2.1 Connection manager

Connection Manager make the connections among the various nodes of WSN. Few parameters which are common in the both scenarios isshown in table 1:-

Table 1

Parameters	Values
No. of nodes	50,100,150,200
Channel frequency	2.4 GHz
Max. transmission power	1.1m
Attenuation threshold	-100dBm
Minimum Path loss coefficient (ALPHA)	2.5
Physical layer sensitivity	-100dBm
Battery capacity	1000 mAh
Battery voltage	3 V
Network header length	24 bit
Sink address	Node 0

2.2 Mobility Models

ISSN: 0971-1260
Vol-22-NO-30 Special Issue-December-2019

The four different mobility models used in this work are explained below:-

a. GaussMarkovMobility

In this technique, gauss Markov principle is used to control the randomness of movement of the nodes in the environment. We can also call this randomness as Brownian motion. For totally random motion, the value of parameter a called randomness factor is taken to be zero.

***b.* LinearNodeDistributionMobility**

In Linear Mobility model, all hosts are placed at constant distances in a line with an orientation. While applying this mobility technique in the network, we must initialize mobility model parameters, positions as well as orientation values.

c. ConstSpeedMobility

In this technique, the whole movement of the host nodes is performed in controlled manner. Initially, velocity and update interval for each Host is defined. If the velocity is greater than zero, thenthis module calculates a random target position for the Host. This process is repeated after every update interval or when the target position is reached.

***d.* StationaryMobility**

As the name stationary Mobility shows, there is no net movement of the nodes in the network i.e. the whole network is static in nature. So there is an increase in no. of hops required for communication with the sink which directly increase the average energy consumption value of the network.

3 Analysis of UAV based WSN

Four scenarios are created on the basis of node density and analysis of UAV based WSN is performed for all four possible scenarios.Moreover comparison of mobility models is also shown for each scenario.

Scenario 1: node density=50

Table 2

Sr. no.	Mobility models	Energy(mWs)
1	LD	0.0862
2	CS	0.1253
3	GM	0.1193
4	SM	0.1395

ISSN: 0971-1260
Vol-22-NO-30 Special Issue-December-2019

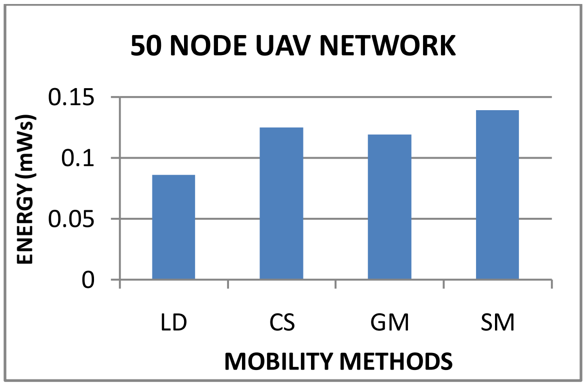

Figure 3: Energy v/s mobility methods

The above table2 and figure 3 shows the energy consumption value of the 50 node UAV network. It is shown that a stationary mobility technique is least energy-efficient whereas linear node distribution technique is the most energy-efficient technique among all mobility techniques.

Scenario 2: node density=100

Table 3

Sr. no.	Mobility models	Energy(mWs)
1	LD	0.0636
2	CS	0.0771
3	GM	0.079
4	SM	0.0839

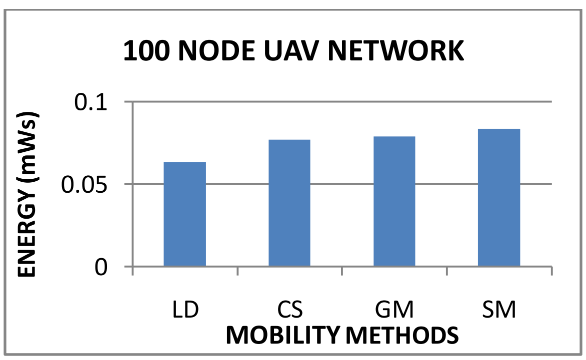

Figure 4: Energy v/s mobility methods

The above table3 and figure 4 shows the energy consumption value of the 100 node UAV network. It is shown that energy consumption achieved by linear node distribution mobility technique is lowest as compared to all mobility techniques.

ISSN: 0971-1260
Vol-22-NO-30 Special Issue-December-2019

Scenario 3: node density=150

Table 4

Sr. no.	Mobility models	Energy(mWs)
1	LD	0.0595
2	CS	0.0681
3	GM	0.0683
4	SM	0.074

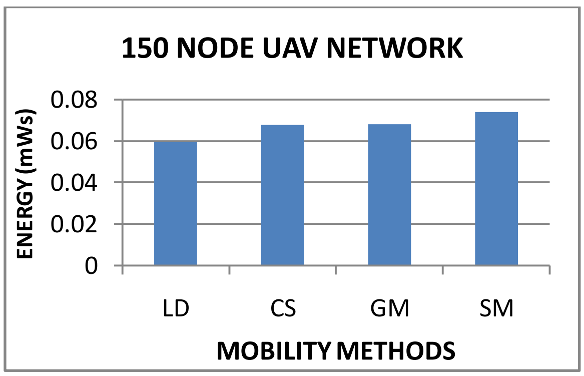

Figure 5: Energy v/s mobility methods

The above graph shows variation in the energy consumption achieved by all the mobility techniques. It is shown that linear node distribution technique consumes lowest energy in comparison to all techniques.

Scenario 4: node density=200

Table 5

Sr. no.	Mobility models	Energy(mWs)
1	LD	0.0574
2	CS	0.0637
3	GM	0.0618
4	SM	0.065

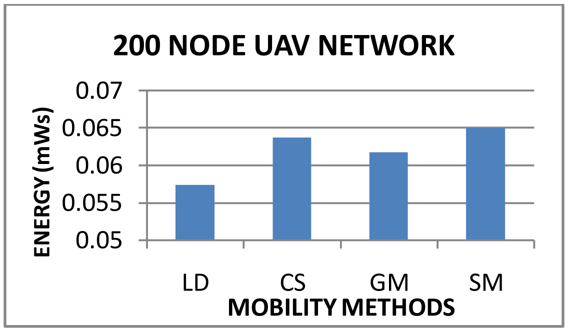

Figure 6: Energy v/s mobility methods

In 200 node scenario, the energy consumption shown above is minimum than all previous scenarios for each mobility model.

4. Conclusion

In this paper, based on parameterswe have simulated different scenarios such as node density and mobility models in case of UAV based WSN and analyzedthe energy consumption value for theabove said parameters.After analyzing above discussed scenarios we have examinedthat, these energy consumption in case of linear node distribution mobility model/technique is lowest among all the mobility models used in the network. It is examined that witha hike in the node density in a particular area, average energy consumption reduces as coverage of the network enhances with increase in no. of nodes in that environment. With anincrease in coverage, less retransmission of data packets are required between sensors and hence improve Quality of service of the network.

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Vol-22-NO-30 Special Issue-December-2019

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