Performance Analysis of AODV and AOMDV Routing Protocols Using ZigBee for Precision Agriculture

Manoj Bishnoi
M.E. Scholar,
Department of Computer Science and Engineering
M.B.M. Engineering College, J.N.V. University
Jodhpur, India

Dr. Alok Singh Gahlot
Assistant Professor,
Department of Computer Science and Engineering
M.B.M. Engineering College, J.N.V. University
Jodhpur, India

***Abstract* - The need for intelligent farming especially in developing countries like India has grown to a greater extent. Moreover, the research in the area of ZigBee based wireless sensor network in precision agriculture, such as monitoring of environmental conditions like soil moisture content, monitoring growth of the crop, and automated irrigation facility has taken a new dimension. Manual collection of data for desired factors can be sporadic, time-consuming, noncontinuous and may produce variations from incorrect measurement taking. Wireless distinct sensor nodes can reduce time and effort required for monitoring the environment along with the guarantying accuracy of data. The logging of data allows for reduction of data being lost or misplaced. The present study compares AODV and AOMDV routing protocols in mesh and star topology on basis of five parameters including Average Energy, Average Throughput, Average End-To-End Delay, Average Jitter and Packet Delivery Ratio. Furthermore, the study compares the two given routing protocols at different distances of 10 meters and 20 meters and at various numbers of nodes including 11, 21 and 31. The NS-2 simulator has been used for experimental setup in the study which provides an environment for the networks, topology and the nodes. The study aims at analyzing the derived results from the experimental setup and thereby suggesting the most suitable topology and routing protocol for developing an effective and efficient model in ZigBee for the real-time implementation in precision agriculture.**

Keywords- Precision Agriculture; Wireless Senor Network; ZigBee; Routing Protocols; AODV; AOMDV; Star Topology; Mesh Topology

I INTRODUCTION

The current scenario of agriculture has drastically changed over the recent years. Today, agriculture routinely employs sophisticated technologies such as temperature and moisture sensors, robots, aerial images, smart power systems, Global Positioning System (GPS) technology and farm management software. These advanced devices, precision agriculture, and robotic systems help save time and money of the farmer and allow businesses to be more profitable, efficient and more environmentally friendly.

Precision agriculture (PA) is a farming management concept based on observing, measuring and responding to inter and intra-field variability in crops. The goal of precision agriculture research is to define a Decision Support System (DSS) for whole farm management with the goal of optimizing returns on inputs while preserving resources [1] [2]. Precision farming involves the application of technologies and principles to manage spatial and temporal variability that is associated with various aspects of agricultural production for improving the environmental qualities and crop performance. The logic behind the precision farming is that production inputs (fertilizer, seeds, chemicals, etc.) should be implied as and where needed.

II WIRELESS SENSOR NETWORK IN PRECISION AGRICULTURE

The major technology that drives precision agriculture is Wireless Sensor Network. The sensor network can guide the farmers' attention towards the crop zones in need of nutrients, water, etc. The derived information can result in an increase in farming efficiency provided that the farmer receives it in time and has the capacity to act on the same. Several kinds of sensors can be consolidated into the sensor node, thus, the conditions of the soil and crops, including illumination, temperature, pests, humidity, crop disease, etc. can be monitored both - remotely and in real-time.

WSN nodes are categorized into three types of network topologies. One is the star topology, wherein each node connects directly to a gateway. Another is cluster tree network wherein each node connects to a node higher in the tree and then to the gateway, and data is routed from the lowest node on the tree to the gateway. Finally, to offer increased reliability, mesh networks feature nodes that can connect to multiple nodes in the system and pass data through the most reliable path available. This mesh link is often referred to as a router [3].

III STATEMENT OF THE RESARCH PROBLEM

At present, automatic systems have few manual operations, insufficient flexibility, and inaccuracy. Therefore, agricultural field requires automatic control system in order to provide adequate irrigation to a specific area and detecting other plant needs right on time without having to go in the field to check each plant individually. This study aims at proposing a based on the wireless sensor network for the control of various parameters of the irrigation system. In addition to the proposed system, the study uses ZigBee technology for the long distance communication

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 6 Issue 08, August - 2017

and network designing. The study also uses routing protocols for transferring data packets. The study focuses on topology and routing protocols for the use in ZigBee technology for precision agriculture. The objective of the study is to identify efficient topology and routing protocol for ZigBee in Precision Agriculture.

IV ZIGBEE: AN OVERVIEW

ZigBee is a wireless networking standard which aims at sensor applications and remote control that is suitable for operating in isolated locations and extreme radio environments. It adds security, network, and application software to the IEEE 802.15.4 standard. With its simple networking configuration and low power consumption, ZigBee is considered to be the most promising standard for wireless sensors. The ZigBee standard supports three device types: ZigBee Coordinator, ZigBee Router, and ZigBee End Device [4] [5]. Each device type employs distinct levels of functionality along with associated cost impacts. Therefore, system developers and equipment manufacturers may execute network topology and trade off functionality with the overall cost. The routing protocols used in ZigBee are based on the Ad Hoc On-Demand Distance Vector (AODV) routing protocol, Motorola's Cluster-Tree protocol and some ideas from Ember Corporation's Grad.

V CLASSIFICATION OF WSN PROTOCOLS

Routing protocols in WSN can be classified depending on the characteristics including Route Establishment, Network Structure, Protocol Operation and Initiator of Communicator. Routing paths can be established in one of three ways, namely proactive, reactive or hybrid. A proactive protocol computes all the routes before they are really needed and store these routes in a routing table in each node. Hybrid protocols use a combination of both proactive and reactive protocols.

On-Demand/Reactive Routing Protocols construct routes only when is necessary to send information. The on-demand protocols have two phases in common – route discovery and route maintenance. In the route discovery procedure, a node wishing to communicate with another node initiates a discovery mechanism if it doesn't have the route already in its cache. The route maintenance phase involves checking for broken links in the network and updating the routing tables. The cited routing protocols in this category are AODV and AOMDV.

(i) ***Ad hoc On-demand Distance Vector (AODV) Routing Protocol-*** AODV routing protocol inherits the good features of both DSDV and DSR. It uses a reactive approach for finding routes and a proactive approach for identifying the most recent path. More specifically, it finds routes using the route discovery process similar to DSR and uses destination sequence numbers to compute fresh routes.

(ii) ***AOMDV or Ad Hoc On-Demand Multipath Distance Vector Routing-*** AOMDV is a multipath extension to the AODV protocol. It establishes route on demand, creates loop free nodes, and maintains fast connectivity and efficient recovery from failures. The key concept in AOMDV is computing multiple loop-free paths per route discovery. The protocol switches route to a different path when an earlier path fails, thus avoiding a new route discovery. Route discovery is initiated only when all paths to a specific destination fail. For efficiency, only link disjoint paths are computed so that the paths fail independently of each other.

VI NS-2 SIMULATION

NS-2 is most widely used simulator by researchers; it is event-driven object oriented simulator, developed in C++ as back-end and OTcl as front-end. If we want to deploy a network then .TCL (tool command language) as scripting language with C++ to be used.

A. Simulation Setup

For simulation, NS-2 (2.35) network simulator is used in the experimental setup. The various simulation parameters which have been used in the experimental setup is depicted in Table 1.

Table 1: Simulation Parameters

Parameter	**Parameter Value**
Channel Type	Wireless Channel
MAC Protocol	IEEE 802.15.4
Routing Protocol	AODV, AOMDV
Network Topology	Star, Peer to Peer (Mesh)
Terrain Size	50 X50 m2
Mode	Beacon Enabled
Traffic Type	CBR
Simulation Time(s)	100
Number of Nodes	11, 21, 31
Traffic Density (No. of sources)	1
Range (m)	10, 20
Queue Type	Drop Tail
Radio propagation models	Shadowing
Antenna Model	Omni-Directional Antenna

B. Performance Metrics

The performance of Zigbee protocol is evaluated using the following metrics:

1. **Packet Delivery Ratio (PDR)-** It is the ratio of data packets successfully delivered to the destination to the data packets generated by the source. A high value of Packet Delivery Fraction indicates that most of the packets are being delivered to the higher layers and is a good indicator of the protocol performance.
2. **Average End-to-End Delay-** This is the average time-delay for data packets from the source node to the destination node. Ideally, the value of end to-end delay should be as low as possible.
3. **Average Throughput-** The successful transmission of data packets in a unit time is known as throughput. It is usually measured in kbps. It should be high.
4. **Average Energy-** It is defined as the amount of energy consumed by each IEEE 802.15.4/ZigBee sensor nodes during transmission, reception, idle and sleeps mode. The unit of energy consumption used in the simulation is mWh.
5. **Average Jitter-** It measures the variation time in the arrival of packets even if they are sent at the same time. These delays may be due to the network congestion, route discovery, queuing, propagation and transmit time. Jitter should be low for better performance of the network.

C. Performance Analysis

NAM window for simulated ZigBee network was used with different number of nodes wherein the one with 11 nodes for Star, and Peer to Peer (Mesh) topology is shown in Figure 1 and Figure 2 respectively. Simulated ZigBee network was analyzed by keeping range 10mt. and 20mt. constant while varying the number of nodes from 11, 21 and 31 and vice versa. The network was simulated using both AODV and AOMDV protocols and the combinations of the nodes were chosen according to star, and mesh topology with distant Number of nodes and Distance.

Figure 1: NAM window with 11 nodes for Star Topology

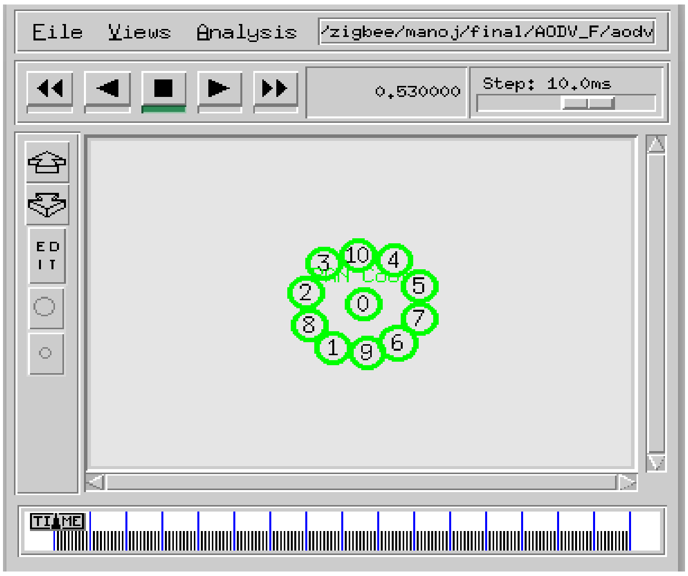
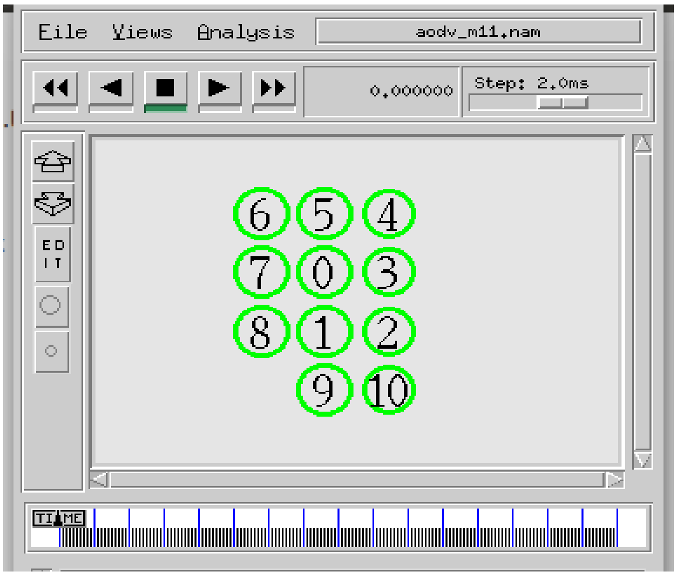


Figure 2: NAM window with 11 nodes for Mesh Topology



1) Performance Comparison of AODV and AOMDV at Different Number of Nodes

With varied number of nodes and fixed distance of 20 meters, the performance of AODV and AOMDV is compared with Star and Mesh Topology basis five parameters namely, Average Energy, Average Throughput, Average Jitter, Average End-to-End Delay and Packet Delivery Ratio.

Figure 3: Average Throughput (kbps) vs. No. of Nodes (AODV and AOMDV; Star and Mesh) at 20 mt.

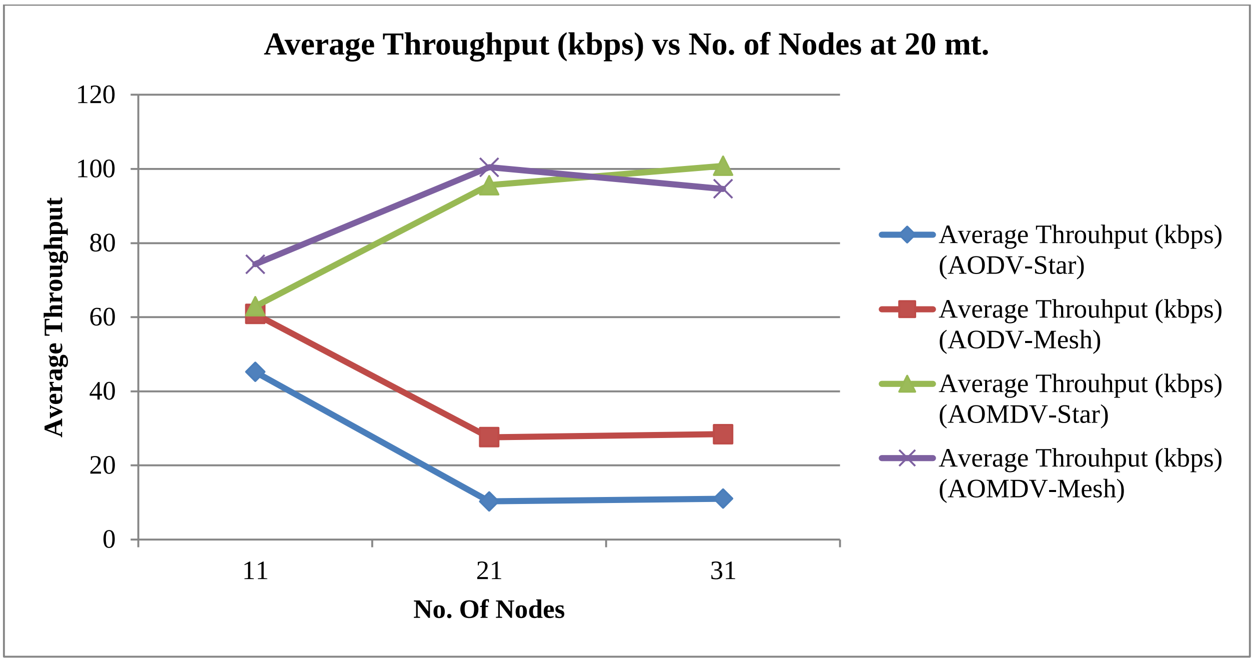
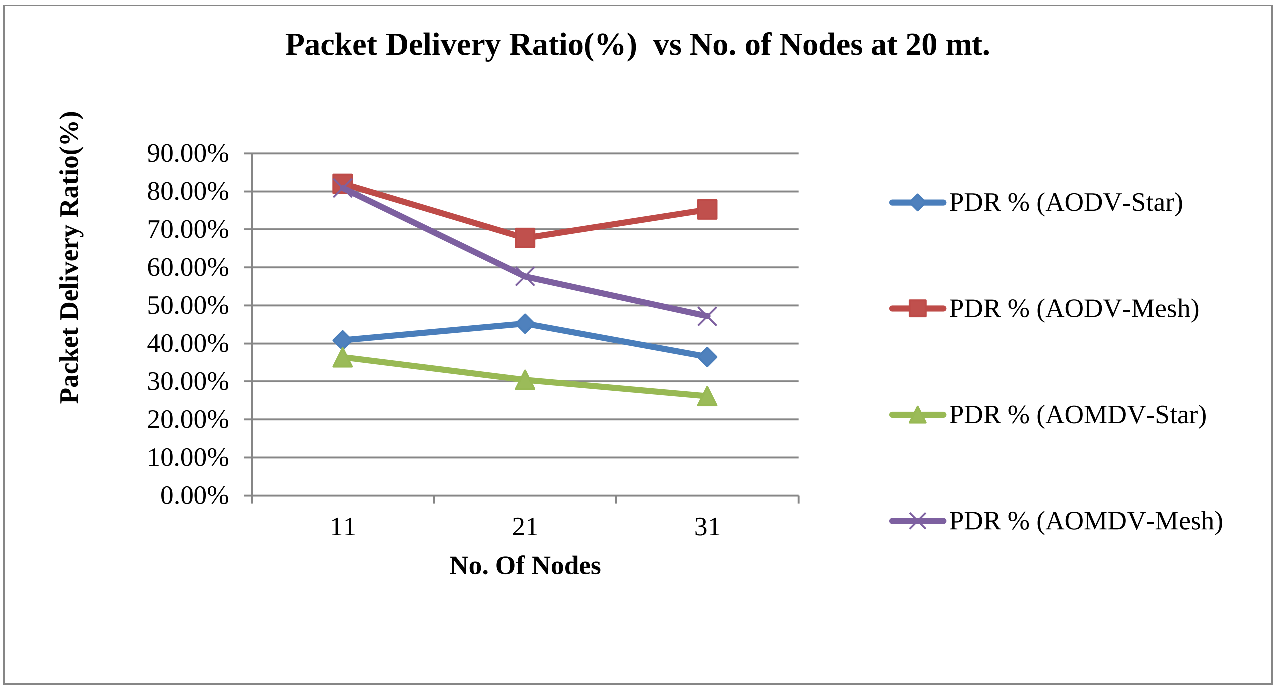


Figure 4: Packet Delivery Ratio vs. No. of Nodes (AODV and AOMDV; Star and Mesh) at 20 mt.



When the number of nodes increases, AODV Star consumes less Average Energy, AOMDV Star gives better Average Throughput due to multipath, AODV Mesh gives less Average Jitter and less Average End-To-End Delay, and higher Packet Delivery Ratio.

2) Performance Comparison of AODV and AOMDV at Different Distances

With fixed number of nodes i.e. 31 and at different distances of 10mt and 20mt, the performance of AODV and AOMDV is compared with Star and Mesh Topology basis five parameters namely, Average Energy, Average Throughput, Average Jitter, Average End-to-End Delay and Packet Delivery Ratio.

Figure 5: Average End-to-End Delay vs. Distance Between Nodes (AODV and AOMDV; Star and Mesh) for 31 nodes

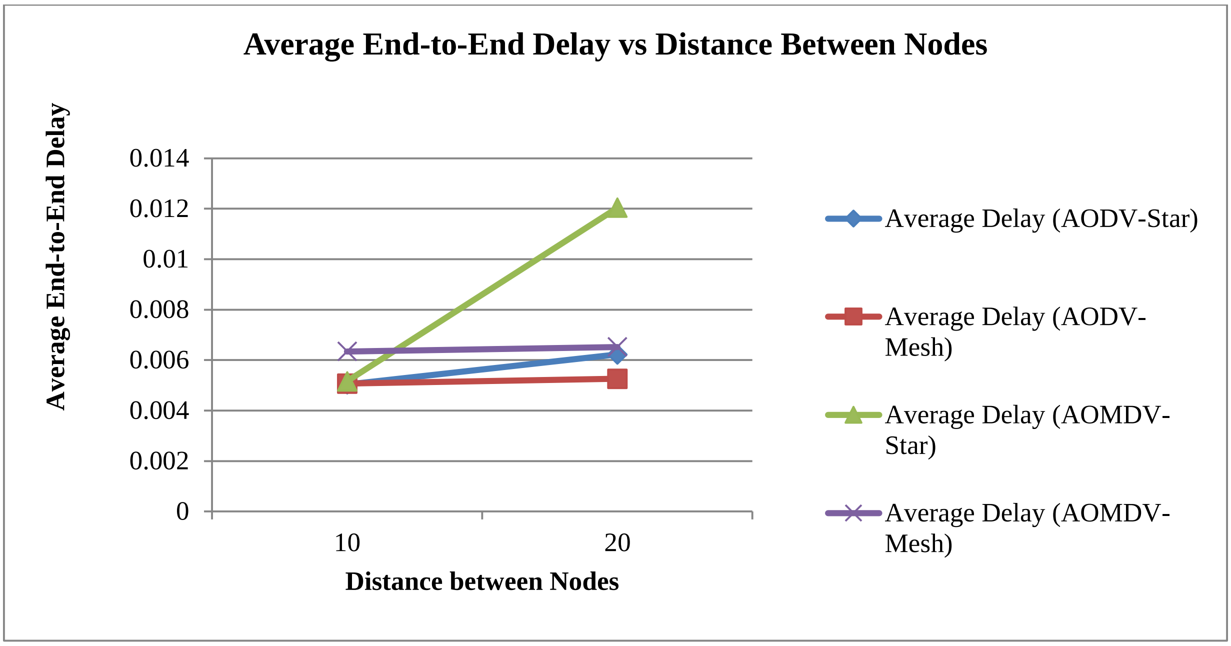
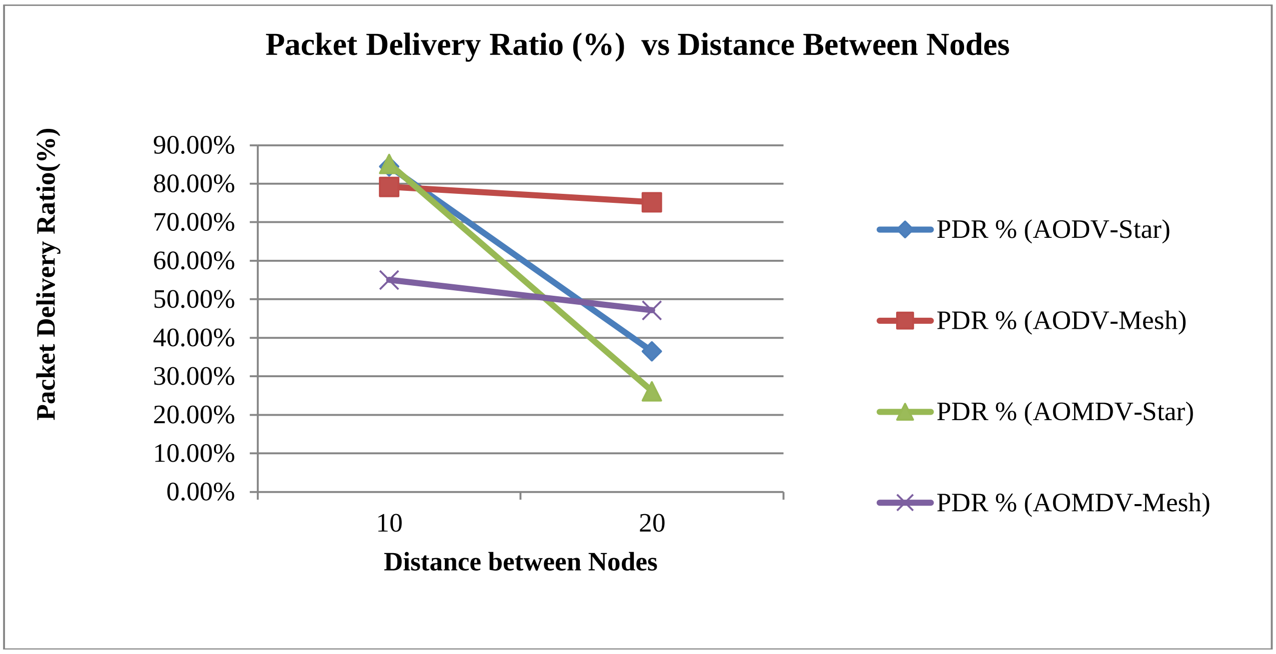


Figure 6: Packet Delivery Ratio (%) vs. Distance Between Nodes (AODV and AOMDV; Star and Mesh) for 31 nodes



When AODV Star, AODV Mesh, AOMDV Star, and AOMDV Mesh were compared, AODV mesh consumes less Average Energy, gives less Average End-To-End Delay, less Average Jitter, higher Packet Delivery Ratio, and AOMDV Star gives better Average Throughput due to multipath.

VII CONCLUSION

By forming a wireless sensor network, a good monitoring system can be developed in the various crop field areas. In this paper, two routing protocols i.e. AODV and AOMDV (for star and mesh topology) were compared on different performance parameters at different number of nodes and at different distances wherein it was derived that, AODV Mesh consumes less Average Energy, gives less Average End-to-End Delay, less Average Jitter, less Average Throughput, and higher Packet Delivery Ratio. It has been retrieved that accept in the case of Throughput (wherein AOMDV Star has better performance), AODV Mesh is overall better performer at increasing number of nodes and at increasing distances between nodes for the use in ZigBee technology for precision agriculture. In future work, we can implement further modification in AODV routing algorithm and make it even more efficient.

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 6 Issue 08, August - 2017

REFERENCES

[1] McBratney, B. Whelan, T.Ancev, “Future Directions of Precision Agriculture”, *Precision Agriculture*, 2002
[2] Whelan, B.M., McBratney, A.B., 2003. Definition and Interpretation of potential management zones in Australia, *International Proceedings of the 11th Australian Agronomy Conference, Geelong, Victoria*, 2003.
[3] T.A. Shiny, R. Anju, “Multi Channel Assignment for Path Selection in Multi Hop Wireless Sensor Network”, *International Journal of Advanced Research in Management, Architecture, Technology, and Engineering*, Vol. 2, 2016
[4] Wireless sensor networks, Chapter 2, retrieved from http://shodhganga.inflibnet.ac.in:8080/jspui/bitstream/10603/38549/7/07_chapter2.pdf, accessed December 4, 2016
[5] M. Sveda, P. Benes, R. Vrba and F. Zezulka, “Introduction to Industrial Sensor Networking,” *Handbook of Sensor Networks*: *Compact Wireless and Wired Sensing Systems*, 2005, pp. 10-24.