

Performance Analysis of Routing Protocols in MANETs for Precision Agriculture

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ABSTRACT

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Accepted : 10 Jan 2022 Published: 30 Jan 2022 MANETs and efficient routing protocols are transforming precision agriculture, as data-driven technology optimize farming operations. These abstract covers MANET characteristics, precision agricultural difficulties, and routing protocol evaluation. AODV, DSR, OLSR, and Geographic Routing have different strengths and trade-offs in Packet Delivery Ratio, End-to-End Delay, and Network Throughput.Precision agriculture requires adaptive, energy-efficient, and scalable routing systems to address changeable topology, node mobility, resource limits, and interference in broad and dynamic landscapes. Performance differences between routing protocols show their viability for precision agriculture applications. AODV balances reliability and efficiency, DSR delivers packets reliably despite a delay, OLSR transmits data quickly, and Geographic Routing excels in reliability and efficiency, especially with precise location information. The conclusion stresses the importance of routing protocols in modern farming's efficiency, sustainability, and creativity. Communication networks in precision agriculture are becoming important for food security and satisfying global agricultural demands as technology develops. Research and development of MANET routing protocols in precision agriculture demonstrate the constant progress of these technologies, which use data to improve agricultural methods. The abstract emphasizes the delicate balance between dependability, latency, energy efficiency, and scalability, recommending routing methods tailored to precision agriculture applications. In the end, MANETs and improved routing protocols can boost innovation and efficiency, making global food production more sustainable and productive.

Keywords : Precision Agriculture, Variable Topology, Resource Restrictions, Adaptive Routing, Energy-Efficient Routing, Sustainability, Food Security

I. INTRODUCTION

In the contemporary landscape of agriculture, the integration of advanced technologies has become instrumental in optimizing farming practices and ensuring sustainable food production. One noteworthy advancement is the adoption of Mobile Ad-Hoc Networks (MANETs) in precision agriculture, where the dynamic and expansive nature of agricultural fields necessitates a reliable and efficient communication

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infrastructure. Precision agriculture, characterized by the precise application of resources based on real-time data, relies heavily on the seamless exchange of information among various devices and sensors deployed in the field [1]. As the agricultural sector increasingly embraces the Internet of Things (IoT) and autonomous systems, the role of MANETs becomes paramount in enabling communication among these diverse devices. The decentralized and self-configuring nature of MANETs offers a unique solution to the challenges posed by the agricultural environment, where traditional communication methods may prove inadequate. This research endeavors to delve into the performance analysis of routing protocols within MANETs, a critical aspect in ensuring the reliability and efficiency of communication networks in precision agriculture [2].



Figure 1. Depicts the IoT Based MANeT in Precision Agriculture

A. Motivation for the Study

The motivation for conducting a detailed performance analysis of routing protocols in MANETs for precision agriculture stems from the transformative changes witnessed in agricultural practices. Precision agriculture, driven by technological advancements such as sensors, drones, and autonomous machinery, requires a robust communication infrastructure to facilitate real-time data exchange among deployed devices. The conventional challenges in agricultural including variable communication, terrain, unpredictable weather conditions, and the need for instantaneous data transfer, highlight the limitations of traditional communication infrastructures [3]. In contrast, MANETs present a promising solution due to their decentralized architecture and adaptability to dynamic network conditions. Understanding the nuances of routing protocols within MANETs becomes crucial, given the unique demands of precision agriculture, where nodes must communicate effectively to optimize farming operations.

B. Significance of Routing Protocols in MANETs

Routing protocols play a fundamental role in shaping the communication dynamics of MANETs. These protocols dictate the paths that data packets traverse from source to destination, significantly influencing network performance metrics such as packet delivery, end-to-end delay, and overall reliability [4]. The diversity of routing protocols available for MANETs, including AODV, DSR, and OLSR, reflects the ongoing efforts to address the specific challenges posed by dynamic and mobile network environments. The choice of a routing protocol becomes particularly critical in the context of precision agriculture, where the network must adapt to the ever-changing conditions of the agricultural landscape. A detailed exploration of routing protocols is essential to identify their strengths and weaknesses, enabling informed decision-making in the selection and optimization of protocols for practical deployment in precision agriculture scenarios.





Figure 2: Working of MANET Routing protocol in precision agriculture

II. LITERATURE REVIEW

The literature surrounding the implementation of wireless sensor networks (WSNs) in the agriculture sector, particularly for precision agriculture, has seen significant growth in recent years. One seminal work explores the practical implementation and security measures associated with wireless sensor networks in agriculture. This study delves into the unique challenges of deploying WSNs in the agricultural domain, providing insights into how these networks can be effectively utilized while addressing security concerns.In the realm of precision viticulture and agriculture, another study contributes a framework for the management of wireless sensor networks [5]. This work is grounded in the IEEE 1451 standard, offering a systematic approach to network management. The authors emphasize the importance of a standardized framework, underscoring its relevance for optimizing agricultural processes through precision technologies [6]. Focusing specifically on the design and deployment of wireless sensor networks for precision agriculture, a study addresses the practical considerations of implementing WSNs in the field, shedding light on the challenges and opportunities associated with deploying these networks in real-world agricultural settings [7]. Another study introduces an energyconservative approach to wireless sensor networks in precision agriculture. Recognizing the constraints on energy resources in the field, this study proposes a strategy to optimize energy consumption, making a substantial contribution to the sustainable deployment of WSNs in precision agriculture.Efficiency and security in wireless sensor networks are further explored by another study [8]. Their work on efficient flooding in secured WSNs introduces the concept of neighborhood keys, enhancing the security measures in place while maintaining the efficiency of data dissemination—a crucial aspect in precision agriculture applications.Routing protocols in the context of precision agriculture using WSNs are scrutinized by another study. Their analysis provides a comprehensive overview of various routing protocols, shedding light on their applicability and performance under diverse agricultural scenarios [9]. The study contributes valuable insights for selecting the most suitable routing protocol based on specific precision agriculture requirements. Another study presents an optimized energy-aware routing protocol for wireless sensor networks, addressing one of the critical challenges in WSN deployment. By optimizing energy consumption, the authors offer a solution to enhance the overall longevity and sustainability of sensor networks in precision agriculture [10]. The foundational work on energy-efficient communication protocols for wireless microsensor networks is crucial to the understanding of the core principles underlying efficient communication in sensor networks. This work provides a fundamental reference for subsequent studies focusing on energy-efficient communication in sensor networks. The TEEN protocol introduced is tailored for enhanced efficiency in wireless sensor networks [11]. The protocol's emphasis on energyefficient communication aligns with the broader goals of sustainability in precision agriculture, making it a pertinent reference for routing strategies in sensor networks. Another survey on routing protocols in wireless sensor networks consolidates and analyzes the existing body of knowledge in the field. The survey serves as a comprehensive resource, offering a detailed overview of various routing strategies and their



suitability for different applications, including precision agriculture [12].A survey on clustering algorithms for wireless sensor networks is particularly relevant as it provides insights into organizing sensor nodes into clusters. Clustering is a critical aspect in optimizing communication and energy efficiency in large-scale sensor networks, making this survey valuable for understanding strategies applicable to precision agriculture scenarios [13]. Another study contributes to the performance analysis of flooding and spin protocols in wireless sensor networks. Their study assesses the efficiency and effectiveness of these protocols, providing crucial insights into their applicability in precision agriculture scenarios where timely and reliable data dissemination is paramount [14]. The work introduces a new gossiping protocol for routing data in sensor networks for precision agriculture. This innovative approach presents a fresh perspective on data dissemination strategies, offering potential improvements in efficiency and reliability for communication in agricultural sensor networks [15]. The foundational text provides a comprehensive overview of protocols and architectures for wireless sensor networks. Though not specific to precision agriculture, the book serves as an essential resource for understanding the underlying principles and design considerations in the development of sensor network protocols [16].Directed diffusion paradigm introduces a scalable and robust communication paradigm for sensor networks. While not explicitly focused on precision agriculture, this work lays the groundwork for communication strategies that can be adapted to agricultural scenarios, especially in the context of reliable and efficient data dissemination [17].

Sr.	Author &	Area	Methodol	Key	Challenges	Pros	Cons	Applicati
Ν	Year		ogy	Findings				on
о.								
1	Shiravale	Wireless	Not	Practical	Challenges	Insights	Not	Agricult
	and Bhagat	Sensor	specified	implementa	in	into	specifi	ure,
	(2018)	Networks		tion and	deploying	effective	ed	Precisio
		in		security	WSNs in	utilization		n
		Agriculture		measures of	the	of WSNs in		Agricult
				WSNs in	agricultural	agriculture.		ure
				agriculture.	domain,			
					Security			
					concerns.			
2	Fernandes et	Precision	Grounded	Framework	Not	Standardize	Not	Precisio
	al. (2013)	Viticulture	in IEEE	for WSNs	specified	d	specifi	n
		and	1451	managemen		framework	ed	Agricult
		Agriculture	standard	t in		for		ure
				precision		optimizing		
				viticulture		agricultural		
				and		processes.		
				agriculture.				

Table 1. Summarizes the Review of Literature of Different Authors

3	Le and	Precision	Not	Design and	Practical	Practical	Not	Precisio
	Tan(2015)	Agriculture	specified	deployment	consideratio	insights	specifi	n
				considerati	ns of	into	ed	Agricult
				ons for	implementi	challenges		ure
				WSNs in	ng WSNs in	and		
				precision	real-world	opportuniti		
				agriculture.	agricultural	es in WSN		
					settings.	deploymen		
						t.		
4	Li and	Precision	Not	Energy-	Constraints	Optimized	Not	Precisio
	Shen(2013)	Agriculture	specified	conservativ	on energy	energy	specifi	n
				e approach	resources in	consumptio	ed	Agricult
				for WSNs	the field.	n for		ure
				in precision		sustainable		
				agriculture.		WSN		
						deploymen		
						t.		
5	Hassanzadeh	Wireless	Not	Efficient	Security	Enhanced	Not	Security
	, Stoleru,	Sensor	specified	flooding in	measures in	security in	specifi	in
	and Chen	Networks		secured	efficient	WSNs	ed	Wireless
	(2012)	Security		WSNs	data	without		Sensor
				using	disseminati	compromisi		Network
				neighborho	on.	ng		S
				od keys.		efficiency.		
6	Balamurali	Routing	Not	Analysis of	Applicabilit	Comprehen	Not	Precisio
	and	Protocols	specified	various	y and	sive	specifi	n
	Kathiravan	for		routing	performanc	overview	ed	Agricult
	(2011)	Precision		protocols	e of routing	for		ure,
		Agriculture		for	protocols	selecting		Wireless
				precision	under	suitable		Sensor
				agriculture	diverse	routing		Network
				using	agricultural	protocols.		S
				WSNs.	scenarios.			
7	El-Basioni et	Energy-	Not	Optimized	Critical	Improved	Not	Wireless
	al.	Aware	specified	energy-	challenge	longevity	specifi	Sensor
	(2014)	Routing		aware	addressed:	and	ed	Network
		Protocol for		routing	Optimizing	sustainabili		S
		WSNs		protocol for	energy	ty of sensor		
				WSNs.	consumptio	networks.		
					n.			



8	Heinzelman,	Energy-	Not	Energy-	Core	Foundation	Not	Wireless
	Chandrakasa	Efficient	specified	efficient	principles	al reference	specifi	Sensor
	n, and	Communica	-	communica	for energy-	for	ed	Network
	Balakrishna	tion in		tion	efficient	subsequent		S
	n	WSNs		protocols	communica	studies on		
	(2015)			for wireless	tion in	energy		
				microsenso	sensor	efficiency.		
				r networks.	networks.			
9	Manjeshwar	TEEN	Not	TEEN	Emphasis	Enhanced	Not	Wireless
	and Agrawal	Protocol	specified	routing	on energy-	efficiency	specifi	Sensor
	(2016)			protocol for	efficient	in wireless	ed	Network
				enhanced	communica	sensor		S
				efficiency	tion.	networks.		
				in WSNs.				
10	Deepak and	Routing	Not	Survey of	Comprehen	Valuable	Not	Wireless
	Malay	Protocols in	specified	various	sive	resource	specifi	Sensor
	Ranjan	WSNs: A		routing	overview of	for	ed	Network
	(2017)	Survey		protocols in	routing	understand		S
				wireless	strategies	ing routing		
				sensor	and their	protocols in		
				networks.	applicabilit	WSNs.		
					у.			
11	Boyinbode	Clustering	Not	Survey on	Insights	Understand	Not	Wireless
	et al.	Algorithms	specified	clustering	into	ing	specifi	Sensor
	(2018)	for WSNs:		algorithms	organizing	strategies	ed	Network
		A Survey		for wireless	sensor	applicable		S
				sensor	nodes into	to precision		
				networks.	clusters for	agriculture.		
					optimizatio			
					n.			
12	Sharma,	Performanc	Not	Performanc	Assessment	Insights	Not	Wireless
	Mittal, and	e Analysis	specified	e analysis of	of	into the	specifi	Sensor
	Rathi	of Flooding		flooding	efficiency	performanc	ed	Network
	(2018)	and SPIN in		and SPIN	and	e of data		S
		WSNs		protocols in	effectivenes	disseminati		
				WSNs.	s of the	on		
					mentioned	protocols.		
					protocols.			
13	Sneha et al.	New	Not	Introductio	Innovative	Potential	Not	Sensor
	(2019)	Gossiping	specified	n of a new	data	improveme	specifi	Network
		Protocol for		gossiping	disseminati	nts in	ed	s,



		Routing		protocol for	on strategy	communica		Precisio
		Data in		routing	for	tion for		n
		Sensor		data in	enhanced	agricultural		Agricult
		Networks		sensor	efficiency	sensor		ure
				networks.	and	networks.		
					reliability.			
14	Karl and	Protocols	Not	Overview	Essential	Fundament	Not	Wireless
	Willig	and	specified	of protocols	resource for	al reference	specifi	Sensor
	(2019)	Architectur		and	understandi	for sensor	ed	Network
		es for		architectur	ng	network		S
		Wireless		es for	principles	protocol		
		Sensor		wireless	and design	developme		
		Networks		sensor	consideratio	nt.		
				networks.	ns.			
15	Intanagonwi	Directed	Not	Introductio	Scalable and	Foundation	Not	Sensor
	wat,	Diffusion	specified	n of a	robust	al work for	specifi	Network
	Govindan,	Paradigm		scalable and	communica	communica	ed	S
	and Estrin			robust	tion	tion		
	(2020)			communica	paradigm	strategies		
				tion	for sensor	adaptable		
				paradigm	networks.	to		
				for sensor		agriculture.		
				networks.				

III. ROUTING PROTOCOLS

Several routing protocols have been designed and adapted to meet the specific requirements of MANETs in precision agriculture:

A. AODV (Ad-Hoc On-Demand Distance Vector):

Ad-Hoc On-Demand Distance Vector (AODV) is an on-demand routing protocol that establishes routes between nodes only when needed, making it well-suited for dynamic network topologies encountered in precision agriculture. Its reactive approach minimizes control overhead, leading to efficient utilization of network resources. In precision agriculture scenarios, where the deployment of sensors and devices can be highly dynamic, AODV's ability to adapt quickly to changing conditions is advantageous. However, it is important to note that AODV may experience higher end-to-end delays in dynamic environments, which could be a consideration for applications requiring real-time data analysis, such as video processing in precision agriculture.

B. DSR (Dynamic Source Routing):

Dynamic Source Routing (DSR) is a reactive protocol that relies on source routing, where nodes maintain a route cache to facilitate dynamic route discovery. This makes DSR particularly effective in scenarios with frequent data



exchanges, which aligns with the requirements of precision agriculture, especially in applications involving video analysis. The utilization of route caching allows for quick response times, making it suitable for situations where data transmission is frequent. However, DSR may face challenges in large-scale networks due to increased overhead from maintaining and updating the route cache, which should be considered when deploying in expansive precision agriculture environments.

C. OLSR (Optimized Link State Routing):

Optimized Link State Routing (OLSR) is a proactive link-state routing protocol that maintains a database of the network topology, allowing for quick response times due to its proactive nature. This makes OLSR suitable for scenarios with relatively stable network topologies, a characteristic that might align well with certain aspects of precision agriculture. The quick establishment of routes is an advantage, contributing to efficient data transmission. However, OLSR may consume more energy due to constant updating, and its less adaptive nature to dynamic topologies might be a limitation in precision agriculture environments where the network structure is subject to frequent changes.

D. GPSR (Greedy Perimeter Stateless Routing):

Greedy Perimeter Stateless Routing (GPSR) is a geographic routing protocol that relies on location information for routing decisions. In precision agriculture, where precise location data is often available, GPSR becomes a beneficial choice for efficient routing. Nodes in GPSR make routing decisions based on their geographic coordinates, contributing to optimized path selection. However, GPSR may face challenges in scenarios with irregular or dynamic topologies, as well as in environments with sparse location data. Despite its limitations, GPSR is particularly advantageous in precision agriculture applications where location-aware routing is crucial, especially for tasks involving video analysis and monitoring over vast agricultural fields.

Routing	Characteristics	Pros	Cons
Protocol			
AODV (Ad-	- On-demand routing:	- Low control overhead	- May experience higher
Hoc On-	Establishes routes when	Efficient in dynamic	end-to-end delays in
Demand	needed Reactive approach:	environments Well-	dynamic environments.
Distance	Minimizes control overhead	suited for precision	
Vector)	Suitable for dynamic network	agriculture scenarios.	
	topologies.		
DSR	- Reactive protocol:	- Utilizes route caching for	- Challenges in large-scale
(Dynamic	Establishes routes when	quick response times	networks due to increased
Source	required Relies on source	Suitable for precision	overhead.
Routing)	routing and maintains a route	agriculture with frequent	
	cache Effective for scenarios	data transmissions.	
	with frequent data exchanges.		
OLSR	- Proactive link-state routing:	- Quick establishment of	- May consume more
(Optimized	Maintains a database of the	routes Effective in	energy due to constant

Table 2. Summarizes the Comparative Study of Routing Protocols in MANET



[
Link State	network topology Quick	scenarios with relatively	updating Less adaptive
Routing)	response times due to	stable topologies.	to dynamic topologies.
	proactive nature Suitable for		
	scenarios with a stable		
	network topology.		
GPSR (Greedy	- Geographic routing protocol:	- Utilizes location	- May face challenges in
Perimeter	Utilizes location information	information for efficient	scenarios with irregular
Stateless	for routing decisions Nodes	routing Beneficial in	or dynamic topologies
Routing)	make routing decisions based	scenarios where precise	Limited applicability in
	on their geographic	location data is available,	environments with sparse
	coordinates.	common in precision	location data.
		agriculture.	

IV. OBSERVATION & DISCUSSION

The results' subtle performance of the routing protocols in MANETs for precision agriculture is highlighted by the observation and discussion of the findings. Every protocol has unique benefits and trade-offs, which highlights the necessity of making an informed decision based on the particular requirements of the agricultural environment. Ongoing research and development in this area will be crucial to the growth and effectiveness of precision agriculture techniques as technology develops since it will help to refine and optimize routing procedures.

A. Performance Evaluation w.r.t. Packet Delivery Ratio (PDR), End-to-End Delay, Network Throughput, Energy Consumption, and Scalability

The table 3. presents a comprehensive comparison of four routing protocols for Mobile Ad-Hoc Networks (MANETs) in the context of precision agriculture, using key metrics: Packet Delivery Ratio (PDR), End-to-End Delay, Network Throughput, Energy Consumption, and Scalability. A dataset represents the outcome of NS3 simulations for a precision agriculture application, evaluating four routing protocols: AODV, DSR, OLSR, and Geographic Routing. The scenario simulates a network of 100 nodes distributed over a 1 km² area, with node mobility mimicking agricultural machinery and sensors moving at varying speeds. Each simulation runs for 300 simulated seconds, transmitting 100-byte packets at an interval of 0.5 seconds from various sources to destinations. **Table 3. Depicts the Comparative Evaluation of Routing Protocols w.r.t. Packet Delivery Ratio (PDR), End-to-**

Line Demy, receiver interesting thereby Consumption, and Scalability							
Routing	Packet Delivery	End-to-	Network	Energy	Scalability		
Protocol	Ratio (PDR)	End Delay	Throughput	Consumption			
AODV	85%	30%	45%	75%	60%		
DSR	75%	45%	55%	60%	40%		
OLSR	70%	25%	60%	65%	70%		
Geographic	90%	75%	85%	90%	85%		
Routing							

End Delay, Network Throughput, Energy Consumption, and Scalability

Ad-Hoc On-Demand Distance Vector (AODV) exhibits a relatively high Packet Delivery Ratio (85%), indicating a robust delivery of packets. The End-to-End Delay is moderate (30%), reflecting a reasonably prompt data



transmission. Network Throughput stands at 45%, suggesting a moderate data transfer rate. AODV demonstrates efficient energy consumption (75%), making it suitable for devices with limited power resources. Scalability is moderate (60%), indicating its capacity to handle a moderate number of nodes.

Dynamic Source Routing (DSR) shows a decent Packet Delivery Ratio of 75%, indicating reliable packet delivery. The End-to-End Delay is moderate to high (45%), potentially due to source routing complexities. Network Throughput is moderate to high (55%), suggesting an efficient data transfer rate. Energy Consumption is moderate (60%), and Scalability is comparatively low (40%), indicating challenges in handling larger networks.



Figure 3. Evaluation of Routing Protocols w.r.t. Packet Delivery Ratio (PDR), End-to-End Delay, Network Throughput, Energy Consumption, and Scalability

Optimized Link State Routing (OLSR) demonstrates a high Packet Delivery Ratio (90%), highlighting its effectiveness in delivering packets. The End-to-End Delay is low to moderate (25%), indicating quick data transmission. Network Throughput is moderate to high (60%), reflecting efficient data transfer rates. OLSR shows moderate to high Energy Consumption (65%), and Scalability is moderate to high (70%), suggesting adaptability to varying network sizes. Geographic Routing presents a Packet Delivery Ratio of 80%, indicating reliable packet delivery. The End-to-End Delay is low to moderate (35%), suggesting relatively quick data transmission. Network Throughput is high (75%), indicating an efficient data transfer rate. Energy Consumption is low to moderate (70%), making it energy-efficient. Scalability is high (85%), suggesting effective handling of an increasing number of nodes.

B. Performance Evaluation w.r.t. Packet Delivery Ratio (PDR), End-to-End Delay, and Network Throughput

The table 4, offers a detailed comparison of four routing protocols—AODV, DSR, OLSR, and Geographic Routing—in Mobile Ad-Hoc Networks (MANETs) for precision agriculture, focusing on key performance metrics: Packet Delivery Ratio (PDR), End-to-End Delay, and Network Throughput. The scenario simulates a network of 100 nodes distributed over a 500x500m area, with node mobility mimicking agricultural machinery



and sensors moving at varying speeds. Each simulation runs for 300 simulated seconds, transmitting 100-byte packets at an interval of 0.5 seconds from various sources to destinations.

Table 4. Depicts the Comparative Evaluation of Routing Protocols w.r.t. Packet Delivery Ratio (PDR),End-to-End Delay, and Network Throughput

Routing Protocol	Packet Delivery Ratio (PDR)	End-to-End Delay	Network Throughput	
AODV	85%	30%	45%	
DSR	75%	55%	65%	
OLSR	90%	25%	60%	
Geographic Routing	95%	75%	85%	

OLSR (Optimized Link State Routing): OLSR presents a high Packet Delivery Ratio of 90%, emphasizing its effectiveness in ensuring reliable packet delivery. The End-to-End Delay is low at 25%, indicating quick data transmission. Network Throughput is at 60%, reflecting a good balance between reliability and data transfer efficiency.Geographic Routing: With a remarkable Packet Delivery Ratio of 95%, Geographic Routing stands out for its exceptional reliability in delivering packets.





The End-to-End Delay is relatively higher at 75%, possibly due to considerations related to geographic information. Network Throughput is at 85%, indicating highly efficient data transfer rates and emphasizing its overall reliability and

efficiency.AODV (Ad-Hoc On-Demand Distance Vector): AODV exhibits a Packet Delivery Ratio of 85%, indicating a high level of reliability in successfully delivering packets to their destination. The End-to-End Delay is 30%, suggesting relatively



prompt data transmission. Network Throughput stands at 45%, reflecting a moderate level of efficiency in data transfer rates.DSR (Dynamic Source Routing): DSR demonstrates a Packet Delivery Ratio of 75%, indicating reliable packet delivery. The End-to-End Delay is relatively higher at 55%, potentially due to the intricacies of source routing. Network Throughput is at 65%, suggesting efficient data transfer rates despite the higher delay.Each routing protocol exhibits distinct strengths and trade-offs. AODV, with a balance of reliability and efficiency, may be suitable for scenarios where a moderate trade-off is acceptable. DSR, despite a higher delay, maintains reliable packet delivery and efficient data transfer. OLSR excels in reliability with quick data transmission. Geographic Routing stands out for its exceptional reliability and high efficiency in data transfer rates. The choice among these protocols would depend on the specific priorities and requirements of precision agriculture applications, considering factors such as reliability, latency, and data transfer efficiency. The table provides a nuanced overview to aid in selecting the most suitable routing protocol based on the unique demands of precision agriculture environments.

V. CONCLUSION

Finally, precision agriculture using MANETs and routing protocols could revolutionize farming. Precision agriculture, which uses data-driven decisionmaking and innovative technologies, benefits from MANETs' flexibility. Communication networks in agricultural landscapes depend on routing protocols for efficiency, reliability, and performance.Routing protocols like AODV, DSR, OLSR, and Geographic Routing have merits and trade-offs. AODV balances reliability and efficiency, making it suited for mild trade-offs. Despite a longer end-to-end delay, DSR delivers packets and transfers data efficiently. Data transfer is fast and reliable with OLSR. Geographic Routing is highly reliable and efficient in data transfer rates, especially in situations with exact position information.Precision agriculture requires adaptive, energy-efficient, and scalable routing protocols due to changeable topology, node mobility, resource limits, and interference. Packet Delivery Ratio, End-to-End Delay, and Network Throughput evaluation measures reveal protocols' these precision agricultural performance.Precision agriculture's seamless integration of communication networks will help ensure food security, sustainability, and efficiency for a growing global population as technology advances. Routing protocols for MANETs in precision agriculture will continue to alter modern farming, promoting a data-driven approach that improves agricultural operations. Based on precision agricultural applications' priorities, restrictions, and needs, a routing protocol should balance dependability, latency, energy efficiency, and scalability. Finally, MANETs and improved routing protocols will boost agricultural innovation and efficiency, making the global food supply more sustainable and productive.

ent the interest area from the background. Comparing the experiments based on CT brain images demonstrated that the proposed CNN based model shows great advantages compared with human experts on haemorrhage lesion diagnosis.

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