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INTERNET OF THINGS (IOT) IN ANIMAL HEALTHCARE AND LOCATION TRACKING

Abstract

Increased adoption of Internet of Things (IoT) and wireless sensor networks (WSN) for livestock monitoring and health management can be attributed to a number of factors, such as the Indian government's efforts to foster technological advancement, the activities of national start-up groups, and digitization. Internet of Things (IoT) technologies and intelligent systems that utilize real-time sensors and wireless technology are directly responsible for the increased simplicity with which owners and farmers can now monitor the health of their animals. In the past, this convenience was unavailable.

The entire process of remotely monitoring the health of these domestic animals can be achieved by integrating IoT into existing systems or developing IoT systems with Wireless Sensor Network that are safe for new-born and young animals. The tracking of an animal's location, health, and other relevant activities including those of domestic, farm, and wild animals can be done remotely through Internet of Things (IoT) technology is being incorporated into a growing number of today's electronic devices. The Internet of Things (IoT) and the collaborative technologies it employs, such as the Wireless Sensor Network, Artificial Intelligence, Data Analytics, and Automation, will enable owners and caregivers of animals and equipment to interact with anything, from anywhere, at any time.

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I. INTRODUCTION

Internet of Things (IoT) stands out as a transformative force in the rapidly evolving landscape of technological innovation, especially in the field of healthcare. This revolution is not limited to human healthcare; IoT technologies have also had a significant impact on animal healthcare.

The incorporation of the Internet of Things into animal healthcare has enabled unprecedented advancements in health management, disease control, and breeding practices [1]. Advanced sensors and Internet of Things (IoT) devices now enable real-time monitoring of animal health, enabling early disease detection and thereby preventing potential outbreaks [2]. These innovations have significantly improved the tracking and localization of animals in both domestic livestock management and wildlife conservation [3].

Better health monitoring has resulted in the prevention of epidemics and better control of chronic diseases among animal populations [4]. Moreover, IoT applications in animal healthcare have helped optimize breeding practices, resulting in healthier offspring and improved genetic lineage tracking [5].

Various techniques are used to monitor wildlife, including catching, trapping, putting animals in custody for research, branding, mutilating, tagging, and banding. Alphanumeric codes are used on tags and bands in the form of radio collars for individual or group identification. Tags are made from a variety of materials, most frequently metal or plastic. Animal development is monitored with the help of radio collars [4]. This method makes use of radio signals to locate a radio-transmitter that has been linked to an animal. Radio-transmitters can be implanted, attached to the skin, into a GPS collar, or wrapped around an animal's neck, ankle, or dorsal fin. This technique allows for the monitoring of animals throughout their lives, something that was previously impossible. There are inherent risks associated with fitting radio collar devices, including as discomfort around the animal's neck, changes in habitat or behaviour, and occasionally animal mortality [5]. Animals must be collared ethically in accordance with common rules, such as verifying device weight, animal total body weight, researching the animal to be collared, etc., in order to prevent these problems. The tiger radio-telemetry focus took place in 1990 in Nagarhole National Park. The Gujarat Forest Department started collaring Asiatic lions in order to study their growth, habitat preferences, and living conditions as well as to keep track of them when they leave the forest and approach areas where people live. 75 lions were fitted with radio collars by Gujarat's state wildlife division; the collars, which have a three-year lifespan, were purchased from Germany. All tigers at Sariska should wear cutting-edge radio collars, which Rajasthan's wildlife management has proposed, along with advanced GPS-enabled VHF collars for round-the-clock monitoring [6]. Elephant tracking is the first and only GPS tracking device designed specifically for elephants in India. Elephant tracking remembers the early warning framework for the moderation of Human-Elephant Conflict, to spare human lives and all harm to crops. It was planned by the Aane Mane Foundation (Bangalore) in selective coordinated effort with Geotraceur (France) and the Centre for Ecological Sciences (Indian Institute of Science, Bangalore). The Wildlife Institute of India (WII) and the state government of Uttarakhand have partnered to tranquillize elephants and equip them with GPS-enabled radio collars so that their movements may be tracked in real-time. The WII team had followed the elephants and kept track of their whereabouts hourly.

The future of Internet of Things in animal healthcare promises even more revolutionary innovations. Experts anticipate a growing role for IoT in veterinary medicine, livestock management, and wildlife conservation as sophisticated sensors and digital technologies continue to develop [6]. The next frontier in animal health includes more personalized care, improved predictive analytics, and the seamless integration of multiple data sources [7].

II. RESEARCH METHODOLOGY

Objective Definition

1. **Primary Focus:** Investigate the utilization, development, and impacts of IoT in Animal Healthcare and Location Tracking.
2. **Scope:** Emphasize research published after 2017, focusing on technological advancements, challenges, and future prospects.

Literature Search Strategy:

3. **Databases:** IEEE Xplore, PubMed, ScienceDirect, Google Scholar.
4. **Keywords:** IoT, Animal Healthcare, Location Tracking, Wearable Sensors, RFID, GPS, Livestock Management, Wildlife Monitoring.
5. **Inclusion Criteria:** Papers published in peer-reviewed journals and conferences, focusing on the integration of IoT in animal healthcare and location tracking.s

III. INITIATIVE BY THE GOVERNMENT OF INDIA AND OTHER COUNTRIES

The Indian Government has brought up effective initiatives to conserve wildlife in the country, and amongst it, most commendable initiatives as per Wildlife Protection Act of 1972 are

1. Strengthening management and protection of infrastructure of national parks and sanctuaries.
2. Protection of wildlife and control of poaching and illegal trade in wildlife products.
3. Captive breeding programmes for endangered species of wildlife.
4. Wildlife education and interpretation.
5. Conservation of rhinos in Assam
6. Protection of tigers, elephants by Radio collar drives.
7. National Breeding Farm (Rastriya Gokul Misssion), Feeding schemes (National Livestock Mission), Treatment (Mobile Veterinary Scheme).
8. Solatium Doubled for Wild Elephant attacks (7.5 Lakhs to 15 Lakhs).

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Table 1: Conservation Methods and Techniques Adopted in Various Countries

Name Of Country	Conservation Method and Technique
India	There are currently 63 million USD set out for tiger conservation in 2019 and 2020 and 35 approved site-specific strategies. The use of SMART and M-STRIPES technology Additionally, in the states of Karnataka, Maharashtra, and Odisha, a Special Tiger Protection Force (STPF) has been formed and is at work. Electronic surveillance has begun in Assam's Kaziranga National Park and on the outskirts of Madhya Pradesh's Ratapani Wildlife Sanctuary. Kanha Tiger Reserve, which covers an impressive 2,185 square kilometers.There are 24 patrolling base camps in the protected region, each equipped with a wifi network, elephant units, dog sniffing squads to patrol buffer zones, and CCTV cameras to keep watch over important tiger habitats around the clock.
Combodia	Efforts have been made to strengthen the capabilities of local communities in regard to SMART patrolling. Increasing the number of people who can help protect wildlife and increasing the amount of time they spend doing so.
Vietnam	The nation is monitoring the movement of wildlife across three priority sites using technology such as drones, camera traps, and satellite navigation devices in order to prevent poaching and monitor wildlife migration patterns.
Bangladesh	Enhanced our capacity for protection through the development of our skills with SMART Patrolling. - As a result of efforts to engage the community, Village Tiger Response Teams and Community Patrolling Groups with a total of 85 members were formed.
Thailand	Efforts are being increased by conducting SMART patrols and workshops.Launch of the Network Centric Anti-Poaching System (NCAPS), with the goal of bolstering conservation and law enforcement initiatives - There are 2,000 residents of the surrounding areas who are employed as park rangers and field assistants in the PAs.
Russia	Tiger habitat has increased by 2 million hectares, and there have been proposals for two new protected areas, which has led to an increase in the amount of land that is protected to 38% of the country's total geographical area. Intelligent green infrastructures include the construction of the first ecological tunnel (which measured 575 meters in length), the Primorye-2 (transport corridor), and a tunnel built under a forested area and spread across cat dispersal routes.

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IV. WIRELESS SENSOR NETWORK (WSN)

Wireless Sensor Networks (WSN) are infrastructure less, self-configuring wireless networks which enable peer-to-peer communication between mobile nodes without centralized control. In the ad hoc setup mobility of nodes is considered. Communication of nodes if beyond transmission range is done via multi-hop communication. Due to the intrinsic limitation of transmission range, each wireless node is responsible for dynamically discovering and associating with other nodes with a view to establish a communication [4-5].

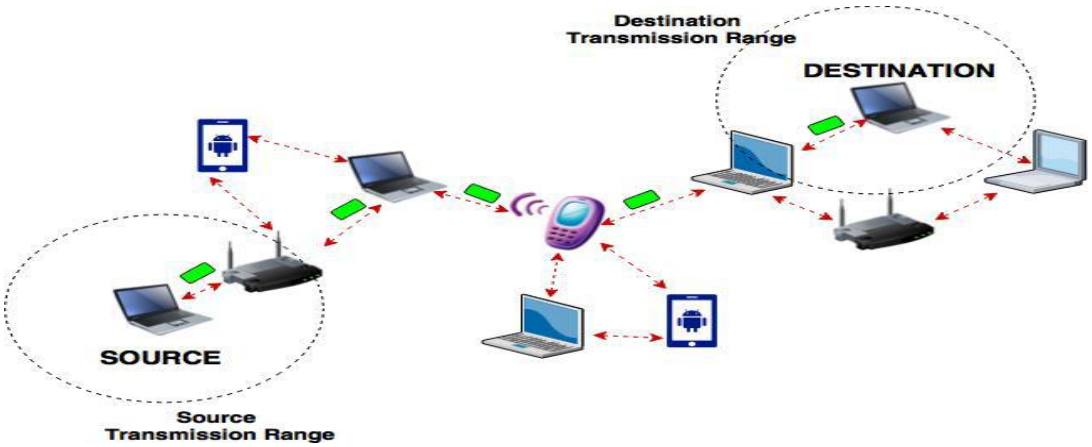

Figure 1: Representation of Network model (Source: Google)

WSNs exhibit following characteristics which make them significantly distinct from wired networks on general and salient aspects which is as follows

1. Due to a lack of centralized server or infrastructure, the nodes in WSN collaborate with each other in a distributed manner to execute network related operations such as path finding, data forwarding, network security etc.

2. WSN nodes share and operate a time-varying wireless communication channel and hence the available bandwidth is relatively less as compared to the wired networks. This often leads to problems such as channel interference, fading and congestion resulting in inferior network throughput.

3. Each WSN node operates on a limited battery energy supplied by either Nickel-Cadmium or Lithium-ion batteries with no capability to harvest their own power. Therefore, implementing energy efficiency techniques is important for the longevity of the network[6]

4. Due to node mobility, WSNs are dynamic in nature and hence are often prone to frequent topological changes. As a result, asymmetric and inconsistent connections exist between nodes which ultimately results in session disconnection and inferior packet delivery.

5. **Dynamic Topologies**: Dynamic topologies: Because nodes are unrestricted in their movement, the network topology, which is often multihop, is subject to sudden and unforeseen changes as well as the possibility of bidirectional and unidirectional linkages [5].

6. **Bandwidth-Constrained and Variable Capacity Links**: Links with changeable capacity and limited bandwidth will continue to be much less capable than their hardwired counterparts. Additionally, even with multiple access, fading, noise, interference, and other factors taken into consideration, when compared to the radio's maximum throughput, the actual throughput of wireless communications is frequently significantly lower transmission rate. Because of the relatively low to moderate connection capacities, congestion is typically the norm rather than the exception, which indicates that total application demand will probably frequently approach or exceed network capacity. Because the mobile network is frequently just an extension of the fixed network infrastructure, mobile ad hoc customers will expect the same services. These expectations will only continue to rise in tandem with the expansion of applications for multimedia computing and collaborative networking.

7. **Energy-Constrained Operation**: A WSN's nodes may use batteries or other finite energy sources to power some or all of them. Energy conservation may be the most crucial system design criterion for these nodes. Applications for collaborative networking and multimedia computing are on rise.

8. **Limited Physical Security**: Mobile wireless networks are typically more susceptible to physical security threats than fixed cable networks. The increased likelihood of eavesdropping, spoofing, and denial-of-service attacks must be taken into consideration. Existing link security measures are frequently implemented by wireless networks to reduce security risks. The advantages of the decentralized nature of network governance in WSNs outweigh the disadvantages of more centralized systems' single points of failure.

V. PROBLEMS INVOLVED IN DATA ROUTING PROTOCOLS

The problem has been consolidated on basis of channel allocation and load balancing issue of the exiting routing protocol

1. High Utilization of the bandwidth leads to more energy losses
2. Trace File Analysis for dynamic channel allocation consumes more transmission cost communication cost and delay in animal monitoring.
3. Optimal Velocity Control of data communication is not considered in this work \Link reliability and packet loss can’t be managed for delay in animal monitoring. Data redundancy controlling mechanism is absent in the existing models which lead to high storage cost.
4. Scalability of the network is not flexible due to non-uniform distribution delay in animal monitoring.

VI. PROBLEMS INVOLVED IN PRESENT MONITORING SYSTEM

1. The rising incident of poaching, illegal trade, killing of wild animals, persecution of animals has undermined significantly the life of many species of wild life. These activities have prompt emotional biological lop-sidedness with loss of many endangered species of wild life.
2. Lack of automated monitoring devices for domestic and farm animals which can ease human labor and also help in early detection of diseases

3. The livestock farmer face cattle health monitoring problem due rise in temperature which lead to various disease
4. Lack of proper scientific and efficient method for identifying the animal pre -estrus cycle, heat detection, calving, mounting of animal in large herds during heat cycle.
5. Lack of devices that can detect the missing animals or theft animals from herd
6. Less implementation of monitoring and tracking devices due to their huge cost.

VII. IMPLEMENTATION OF INTERNET OF THINGS AND PROTOCOLS

An efficient data acquiring and data transmission routing protocol for Wireless Sensor Network towards wildlife health monitoring system will implements solution to handle node scheduling against dynamic load by identify the optimal velocity to the animal. In this much effort has been imposed to be network channel conditioning against dynamic load. The reliability of network is exploited using the exponential weighted moving average method and node was eliminated using revocation process. It will classify or destroy the packets with modification principle by establishing the secure end to end communication with minimum energy and high throughput conditions and grantees network security. The link quality indicator was implemented to detect the node propagation in the network. In order to improve the accuracy of predictions regarding animal habitat procedures within the WSN, a hybrid energy and location aware routing protocol to Cloud enabled Internet of Things based Wireless Nano Sensor Network towards animal health monitoring and tracking has been developed. Proposed protocol implicitly provides the data balancing and energy consumption by reducing the overhead of the network with reference to cache of data in the routing table which contain the trace or monitored information of the node and network status.

VIII. PROPOSED INTERNET OF THINGS (IOT) FRAME WORK

Proposed framework has to further focus to maximize the data transmission rate with multiple packet handling methods. In order to achieve the high data transmission rate, Packet oriented channel-based routing protocol has to be designed to produce the high throughput and other quality of service-related metrics as it lags in the performance due to dynamic network characteristics and diverse data propagation. The suggestion for routing protocol is composed of multiple heuristic in order to achieve high throughput using process as follows

1. Sending the chunk signature with a smaller packet size, as opposed to sending out the entire packet stream chunks, can significantly improve the scheduling viability of the nodes and boost channel throughput.
2. Due to the community clustering trait, nodes in the human mobility model are likely to cluster and travel together. As a result, communication interference between nodes in the same cluster may increase each node's channel utility and make scheduling the nodes more difficult.
3. To schedule the packet transmission and further cut down on transmission time, the distributed packet scheduling technique can be used.
4. In future more applications can be used to monitor and track birds as proposed model due its weight and LiFi connectivity cannot be implemented.
5. Proposed model designed can be further improved by implementing on other domestic animal for monitoring and tracking other applications.

IX. CONCLUSION

Using an efficient path selection solution for information dissemination to the base station, it is possible to design and simulate a novel hybrid energy and location aware routing protocol for a cloud-enabled IoT-based Wireless Sensor Network that can aid in the monitoring and tracking of animal health. Implementation of Metaheuristics based clustering approach can also provide optimal condition during node failure with reduced energy consumption.

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