Role of IoT Technologies for Wildlife

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***Abstract*— Internet of things (IoT) is an integrated system of smart devices that are linked with each other with the assistance of internet. In this system wireless communication is possible through sensors, software and such other technologies. These devices and sensors are in charge of collecting environmental data and this connectivity enables device to cloud communication. This paper analyzes the research of recent years, in order to conserve and protect wildlife. It reviews the concept of IoT with its tools, how can these tools assist to protect and preserve wildlife. It discusses the importance of the UN's 17 substantial goals for sustainable development and its contribution towards conserving wildlife. It includes various different technologies such as LoRa, sensors, RFID radio frequency identification device, BLE, GPS, etc. For better understanding of wild animals, to scrutinize their parameters and natural habitat; IoT has developed ample ways. All serve to create a wide network for the WMS wildlife monitoring system. This paper discusses the development of LoRa's analysis and its implementations. Although IoT offers new pathways in wildlife conservation, it can still be explored further and developed to be applied in this arena.**

Keywords*— *IoT, Wildlife, Technology, Conservation, Monitoring, GPS, Data

I. INTRODUCTION

Out of 17 Sustainable Development Goals of the United Nations the goal that is linked to biodiversity is 15th. Five targets were set to contribute to biodiversity; 15.1, 15.2, 15.5, 15.8 & 15.8 [1]. These targets integrated to focus upon conserving biodiversity like halting illegal hunting and illicit trading of wildlife by products. In 2020, significant actions were taken to lessen the degradation of natural habitats, halt the loss of biodiversity and avert the extinction of endangered species. By 2030, the UN aims to ensure the protection of ecosystems and their biodiversity, consequently to increase production to achieve sustainable development. UN-backed Wildlife Conservation conference 2017, the year's largest wildlife conference summoned in Asia for the first time to put Wildlife in spotlight. Countries that participated in the conference escalated their work with Convention on International Trade in Endangered Species (CITES) to conserve African lion, cheetah, leopard, & wild dog. The theme of this conference was "Their Future Is Our Future _Sustainable Development for Wildlife & People".

IoT can be used in various fields for different purposes. IoT deals with three major fields: Sensing, wireless connection & cloud computing. From the technology viewpoint, IoT refers to the several information transmitting devices, such as radio frequency identification device (RFID), global positioning system (GPS), laser scanners, infrared sensors and many more devices in which the internet integrates to form a huge transmitting network [2]. The aim of this technology is to connect & facilitate the identification management.

Wildlife refers to those untamed animal species that live in a wild area excluding humans. Wildlife does not only include animals but all sorts of organisms that thrive in an ecosystem. Wildlife is an important component of an ecosystem, it participates in the food chain to maintain the balance of flow chart or nature. Our planet's wildlife is in crisis as several species have become endangered due to various different causes; some are being killed or hunted against the law and some being extinct due to climatic changes or unsuitable habitats. Wildlife is often viewed as dangerous and harmful or a threat to people. They are not guarded beyond the protected areas, consequently it reduces and vanishes due to oppression, ill-treatment & loss of habitat [3].

In this technically smart world, wildlife is vulnerable to destruction and it has become very important to ensure its safety & that can be done by keeping a track of the natural world [4]. It is necessary to protect and preserve wildlife from the human world and vice versa. This protection is out of human reach and that is where IoT comes into play. IoT devices such as sensors and cameras can be used to detect the movements of wildlife. It helps to collect the data of their habitat, behaviour & movements. As animals produce sounds to interact with their species or other as well, they communicate for basic activities like feeding, fighting, movement, etc. [5]. Further, the data can assist to improve different strategies for better understanding of the natural world. In the area of wildlife conservation IoT is playing an important role. As with the help of WMS (Wildlife Monitoring System) integrated with IoT tools it provides easy solutions to investigate animals of remote areas and lend a hand to safeguard their lives.

As for humans, it is not possible to scrutinize wildlife without endangering their lives and that is where technology comes handy. It assists to collect data on information of far

distant lands or anywhere on the planet. In this technical world, there is a huge availability of smart devices such as sensors and servers, (e.g., smart phones, tablets, smart sensors, smart buildings, smart vehicles, cellular base stations) and many more. Have you ever wondered, what are these? How do they work? So, these smart devices are integrated with IT (Information Technology) and OT (Operational Technology) making it a connected network to contrive the IoT [6]. IoT is a dense network of connected smart devices operating with the assistance of the internet. It functions as an intelligent programme which uses cloud computing and other computing technology to process and analyze the large quantity of data and further leads the whole process correctly [2]. This technology helps to store and transmit data on the most optimum level, that too very quick and accurate. Big organisations and industries are using IoT to work more efficiently, to increase their outcome. IoT is in high demand in the current digital world, setting a benchmark for future generations. IoT functions as a chain of smart devices. IoT facilitate companies to work smartly and cut down the big expanses. All the transactions processed by IoT are more transparent and accessible. It saves time and hard-work still enhances productivity, hence it is an important technology for the trading world. IoT runs in all fields be it Business, Healthcare, Education, Finance, Agriculture, Manufacturing, Transport, etc. It provides tools to function more easily and effectively, saving time and money.

II. Use Of Iot In Wildlife Conservation

The IoT and machine to machine (M2M) communication technologies, enabled humans to create new solutions in several fields that were unthinkable in the past few decades [7]. Due to constant growth humankind is thriving to strive more and more regardless of the harm they are causing to the natural world and wildlife is a part of it. To check and act responsibly, humans have to address the need to look after the wildlife and seek ways to conserve it. Animals can be tracked and protected in their own habitats without getting disturbed and LoRa is a Low Power Wide Area Network (LPWAN) wireless technology that can be very helpful in communicating over long distances [7]. As animals are mobile and social organisms widely distributed in herd or pack, which results in uncertainty and breakage in communication link. In this situation, LPWAN with an IoT network can be very helpful [9]. This technology consumes very low power and covers a wide range of areas, also provides collars or tags to monitor and track animals in wide areas. With the help of these portable devices GPS sensors and temperature sensors can be implanted on animals. LoRa networks perform the operations and time bound monitoring, e.g. location tracking and mapping. There are two types of nodes in the BLE (Bluetooth Low Energy), first is Source node that generates data and second is Sink node that translates data between nearby network and LoRa gateway [8]. Machine to machine communication among sensor nodes in WMS will assist in data processing and sharing for decision making. To achieve this, WMS should be aimed to have high reliability and high energy efficiency [9]. With IOT embedded systems animals can be detected by their sounds or signals, it can identify and classify the species of a particular animal. The sounds in the environment can be captured in microphones and then sent to the RF (radio frequency) network. This whole system work in three steps: by receiving audio initial signals, it identifies the features of an animal using Mel Frequency Cepstral Coefficient, autocorrelation performs the identification of age, state of mind is detected by taking signals using GFCC with support vector machine [5]. Wildlife conservation is fundamental to earth's ecological construction and with the assistance of computer vision technology, we can effectively monitor wildlife [12]. Fig.1 illustrates the implementation of LoRa and IoT for wildlife monitoring through collar node (sensor node). The collar node integrated with multipe sensors and GPS for sensing the status of wildlife with in geo-fencing.

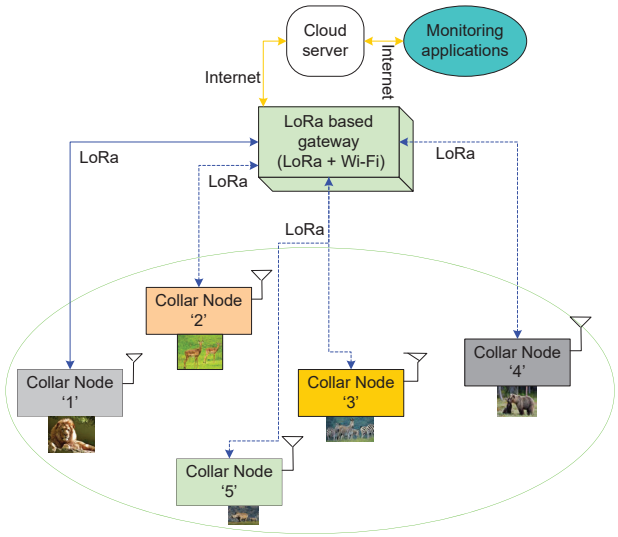

Fig. 1. LoRa based architecture for wildlife monitoring

Wildlife damage is also an agricultural issue but also it can create disturbance to daily lives of people living in remote rustic areas. In this scenario, IoT program is embedded with a cage, camera, target counter, sensors, etc. through an informative network [10]. In past years, the internet of things IoT enabled drones also known as UAVs are widely used in wildlife monitoring. Drones provide a low cost and risk free facility and it is easy to use for monitoring natural habitats of wildlife. The communication between flying drones and smart devices deployed in animal bodies is susceptible to any attack [11]. IoT has an enormous ability to play a major role in the forest ecosystem management. The conservation of wildlife and their habitats, avert forest soil degradation, and this balance can be obtained by forest management with the help of, IoT [13]. Wildlife conservation is the process of preserving flora and fauna. Wildlife plays an important role in stabilizing natural life of ecosystem. IoT can enable real time tracking and monitoring animal movements with different smart devices [14]. In back few years, the IoT has enabled Unmanned Aerial Vehicles (UAVs) such as drones, are widely used to monitor wildlife [15]. Every time animals get hit by vehicles which proves dangerous to both animal and human life. By utilizing technology of IoT a lot can be done as image recognition, data processing and visualization. Such smart devices are intended to prevent WVCs by triggering sensors and warning drivers beforehand .Table I presents the implementation of IoT for wild life.

III. Challenges

Recently, technology has taken over a large part of everyone's life. However, the technology of IoT makes laborious human tasks more convenient and practical but it also comes with the deployment of various challenges.

Table I. Studies Of Iot For Wildlife

Ref	Objective	Findings
[16]	Analyzed IoT based platform for wildlife monitoring	GSM based tracker are realized.
[17]	An innovative IoT network architecture in dual radios for wildlife monitoring	The proposed network doubles network lifetime for distinct traffic rates.
[18]	The development and execution of a distributed, end-to-end IoT system for tracking wildlife.	The suggested method precisely determines, deer bears, coyotes, and empty images while substantially lowering image transfer time and bandwidth requirements.
[19]	IoT based system automatically detects passive tags embedded to wildlife and upload it to cloud	The proposed system delivered effective result by deploying 90 sensor modules in 30-hectare wildlife sanctuary

Power consumption: The most prominent challenge with IoT in wildlife monitoring is power consumption. As computing is an inescapable part of all aspects in today's life, making power consumption an inescapable issue. So it is essential for deployed devices to be equipped with long lasting batteries. Therefore, IoT platform uses low power solutions like BLE (Bluetooth lower energy) and LPWAN (low power wide area network).

Delay in data processing: second challenge that is faced in monitoring wildlife is hindrance in data processing, because of wide ranging areas and remote locations. As animals' movements are not predictable they can move to distant places, even out of the range of their collared sensors and other smart devices. So, the accuracy of data processing is not certain.

Chances of failure: Chances of failure in data processing is also a challenging aspect because of different unpredictable reasons. Due to wide ranging areas the deployed devices can go through different weather conditions, rain, thunderstorm, hail storm, etc. consequently the chances of failure are high.

Security of data: Security of data is very important aspect and while monitoring wildlife its not quite easy to secure their data because of the distance they keep moving in. As deployed devices are exposed everywhere without any safeguard its very easy for hunters to poach species of endangered animals by stealing their data.

IV. Conclusion

This review paper cover IoT platforms for wildlife monitoring, habitat observation, location tracking and behaviour recognition. A monitoring system consist of sensing, communicating, visualising and tracking hardware and software applications. The present review paper comprises to find out ways to protect Wildlife using the technology of IoT. IoT assists in many different ways to monitor wildlife within its habitat or even wide parameters. Moreover, it provides a large area network on very low energy consumption with the help of a LoRa server. Also, BLE with LoRa can lay out a required WMS. In this constantly growing world, people are evolving at a quick pace. They strive to achieve more and more which is a natural human tendency. To accomplish more, they engineer required sources in order to execute what they want. With this motive there comes a responsibility in order to gain, one needs to give first or later in case of humans. If natural world resources are being protected they should be safeguarded as well; similarly, wildlife also needs to be preserved.

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