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5G Technology:AFuturistic Solution for Wildlife Monitoring

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A B S T R A C T

Wildlife is an important part of the ecosystem and helps maintain the balance in the food chain, thereby maintaining ecological stability. The economic valuation of the benefits that flow from wildlife protected areas runs in millions of dollars but unfortunately, so does its illegal trade. Both the aspects make it imperative and urgent that wildlife is efficiently monitored and conserved. Wildlife monitoring is critical so as to know what needs to be protected, as well as identifying patterns like reduction in species as well as climate change effects. However, monitoring of wildlife is currently not achieving its desired goals due to poor law and order conditions as one of the reasons among many. This demands the use of technology for wildlife monitoring to not only increase the access to various regions of wildlife habitat but also the speed at which the data is transmitted for humans to take timely action.5th Generation (5G) cellular networking technology is an advancement to existing global wireless standards not just in terms of network for communicating with people but in new ways to tackle issues of various sectors (such as wildlife). This paper explores various devises available currently for use for monitoring wildlife and their conservation and the advantages of use of 5G over 3/4G with these devices. The paper concludes that the use of 5G would not only increase the speed of accessibility of data to the foresters as well as the scientists but would also allow the use of multiple devices at the same time making wildlife monitoring more effective. This would aid in timely use of data for creating and implementing conservation measures.

Keywords:5G technology, Wildlife, Monitoring, Methods, Remote Sensing.

1. Introduction

With the advent of 5G the day is not far when we would see fully automated systems capable of taking over mundane responsibilities. 1G mobile networks enabled people to exchange information in the form of voice. 2G enabled talking and texting. 3G enabled people to talk, text and exchange data i.e., access the internet. 4G was just a faster version of 3G. 5G will not be just about accessing the data quickly, it would be much more intricate than that in its combined qualities of high-speed connectivity, low latency and vast coverage would enable smart vehicles like cars, trucks and buses to ensure smooth traffic flow on streets (Cisco, 2020). The next-gen mobile networks will operate at very high frequency (between 5-30GHz) for uplink and downlink of data compared with the earlier 1G, 2G, 3G, 4G technologies. Also, 5G network is designed to connect everyone and everything together including machines, objects, and devices virtually (Fig. 1) (Qualcomm Technologies, 2021). The hardware and power requirement are said to reduce with 5G technology to support the smooth operation of the latest 5G smartphones, MS (Main station), BS (Base Station) (Joshi et al. 2020 & Iannnacci 2019). One the major advantages being “Massive IoT” which is the technique to seamlessly connect large number of sensors embedded systems through interfacing broads making connectivity solutions highly low-cost, reliable and time critical (Qualcomm Technologies, 2021; Joshi et al. 2020 & Iannnacci 2019). This would especially be critical in case of wildlife monitoring and protection, which in its current state is largely dependent on monitoring by humans.

Wildlife is an important part of the ecosystem and helps maintain the balance in the food chain, thereby maintaining ecological stability (The National Wildlife Federation, 2021). A study of six tiger reserves in India by IIFM has calculated the flow benefit of US$ 1,202.11 million annually (Anonymous, 2016). Conversely, it is estimated that wildlife is illegally traded for US$8 to 10 million annually (Fearson). Both the aspects make it imperative and

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urgent that wildlife is efficiently monitored and conserved. Wildlife monitoring is an essential part of conservation, thus a key step in protecting endangered species and building animal corridors that will help prevent increased human-wildlife interactions as a result of our invasion of their areas in the name of development in many places of the world (Wildlife ACT, 2021). Wildlife monitoring is keeping track of animal movements, analyzing the distribution of wildlife populations, the state of natural ecosystems, and identifying potential threats to different wildlife species, such as poaching (Keystone Foundation, 2021). The information gained through monitoring aids in better knowledge of the status of various wildlife species, as well as improved wildlife management.Wildlife management relies heavily on population and harvest monitoring to assess the consequences of management measures. Monitoring programmes not only provide an inventory of animals on your land, but they also show whether your habitat management activities are having an impact(Keystone Foundation, 2021; Wildlife ACT, 2021; Shamkuwar, M & Joshi, A 2015). Wildlife monitoring is critical so as to know what needs to be protected, as well as identifying patterns like species reduction and climate change effects (Lake County Forest Preserves 2021).However, monitoring of wildlifeis currently not achieving its desired goals due to poor law and order conditions as one of the reasons among many (Dasgupta, 2016). This demands the use of technology for wildlife monitoring to not only increase the access to various regions of wildlife habitat but also the speed at which the data is transmitted for humans to take timely action. This paper explores the various options that 5G as technology offers for wildlife monitoring.

2. Methodology

Animal identification and monitoring systems are the need of the hour. The technological advancements have made it possible for conservationists, scientists, and the common people to know about animals, their habitats, the threats to them, and different ways to protect wild species especially the ones that are endangered. A typical wildlife monitoring system is made up of some, software, hardware, communication and sensing components, as is shown in Fig. 1, Fig. 2and Table 1.

Table 1: List of components of monitoring unit.

Hardware	MCU, Power Supply, Camera's….
Software	Operating System, Virtual control unit, drivers…
Communication	5G networking protocols
Sensors	Temperature, PIR, microphone, motion, GPS…

Figure 1: Infographic representation of wildlife monitoring.

The power required for the functioning of the components listed in Table 1 can be either taken care by installing solar panels or conventional sources of electricity can be used. With 5G, all the tracking and monitoring in the communication network can be easily done due to very high download and upload speeds (Qualcomm Technologies, 2021& Joshi et al. 2020). The virtual control unit will receive the data from all the monitoring components that can be seen in Fig.2 with the help of 5G networking protocols. One of the mechanisms for wildlife monitoring is the Unmanned Aerial Vehicles (UAVs) that are remotely controlled and managed through embedded autonomous computer programs (Mishra, D &Natalizio, E 2020). UAVs have proven to be effective, robust and reliable at carrying out wildlife monitoring surveys. There is a requirement to completely automate the UAVs as well as establish a reliable transmission of the data that is collected by the UAVs. With the increasing popularity of Artificial Intelligence (AI), UAVs can now provide analytical feedback in real-time (Sweet, 2021).

Another popular mechanism that is used in wildlife monitoring is camera trapping. Camera trapping is sought-after due to its simplicity, versatility and applicability in a wide range of environments. Camera traps give the exact location of a specie, what they are doing, and the status of their population (World Wide Fund for Nature, 2021). A wildlife camera trap is a camera placed at a location where there is maximum possibility of wild animals approaching the location. The camera will automatically trigger the shutter release and photos or video sequences could be taken, without any human intervention (Zoological Society of London, 2021). The Camera trap consists of a Passive Infrared (PIR) Sensor. These sensors are able to detect the presence of an animal by differentiating between ambient background temperature and the swift change in temperaturedue to an animal's presence (World Wide Fund for Nature, 2021). GPS (Global Positioning System) tracking is another recent technology to determine and track the precise location of wild animals. All creatures in nature, the rainforest, and national parks can be identified and tracked using GPS wildlife animal tracking devices. This procedure is far safer for animals and causes no harm to them (Rewire Security, 2021). The movements of the animals can be identified by deploying GPS collars on the target animals. Instead of a transmitter, the animal is supplied with a radio receiver in GPS tracking which picks up signals from specific satellites. A computer in the receiver determines the animal's location and movement. The data collected by the receiver is then sent to a new group of satellites and this transmission will get improvised due to 5G. There are now solar-powered GPS receivers small enough to attach to a bird.

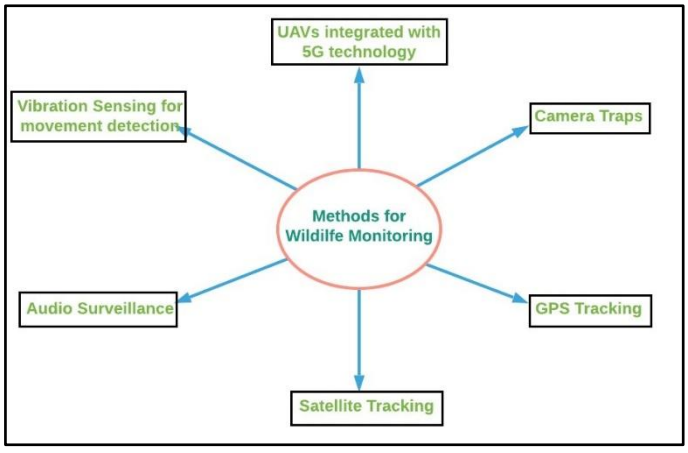

Figure 2: Block diagram representation of elements in wildlife monitoring

Satellite telemetry has been widely utilised in animal tracking. Researchers can track an animal's movement over a period of time without recapturing it after a tracking device has been fitted to it(Perras, M &Nebel, S 2012). In satellite tracking a signal is transmitted to a satelliteinstead of a radio receiver. Scientists don't have to be near the animal in order to detect it'sthrough the signal transmitted by the tracking device (New Hampshire PBS, 2021).By combining neural networks processing with high-resolution satellite imagery, scientists and researchers can obtain reliable statistics for monitoring and mapping migration patterns of wildlife, their habitat as well as tracking endangered species in inaccessible wildlife habitats. This is a significant aid in management and conservation efforts (Satellite Imaging Corporation, 2021). Audio surveillance for wildlife monitoring is yet another popular method that has grown rapidly in recent years. Latest updations in machine learning and computer vision are making it possible for the researcher to access useful information about the ecology from many hours of sound recordings which help to draw conclusions on animal distribution, physiological state, abundance, behaviour and populations. They are also able to draw a concrete conclusion about the of communities of vocalising animals in a survey area.This then helps them to understand the relationship between animals and their 'soundscape' which is their sound environment (World Wide Fund for Nature, 2021).

3. Result and Discussion

However, just use of all technologies would be effective for wildlife monitoring and thus its conservation if all the elements (components of monitoring) will work in sync with each other. Since wildlife is on constant move, these devices can be in power saving mode till any activity is detected. On detection the virtual nodes communicate with each other for the movement detected. For devises like the UAVs that can now provide analytical feedback in real-time, effectiveness of transmission of data in terms of quality and time becomes imperative. To maintain UAV communication beyond the visual line of sight it requires constant and robust connectivity. This is where the requisite of 5G arises (Sweet, 2021). 5G will not only allow UAVs to fly with a lot of accuracy but also transmit data without any delay. With the use of 5G, UAVs can live stream high volumes of high-resolution data which would allow them to operate at higher altitudes for detection of movement of animals.Additionally, with the help of AI/ML identification of the animalspecies would become easy and so would be the transmission of data on geo-coordinates to virtual node of that region to activate the satellite tracking, audio surveillance, camera traps and movement detection units.

Taking the case of camera traps, their increased use for wildlife monitoring is a clear indication that the raw data collected from a camera trap is being used to communicate research findings and to raise awareness about wildlife conservation. Usually for camera traps to function effectively it is important to install them on strong poles or trees with no vegetation in frontare sheltered from the sun. This is to minimize false triggers caused by any movement of

vegetation due to wind. Camera trap technology is constantly evolving, leading to improvements in detection capabilities and image quality (World Wide Fund for Nature, 2021 & Zoological Society of London, 2021). But the current status of the camera traps requires human presence in the forest to collect the data from the camera traps which may take days to reach the remote area where the trap has been installed. Real time transmission of data is the solution but for robust transmission of high-quality images it will require super-fast networks like 5G. With 3G and 4G already in use, it is important to understand the need for 5G in comparison to its older versions. Table 2 talks about the advantages of 5G from a wildlife monitoring point of view as compared to 3/4G.

Table 2: Advantages of using 5G technology in wildlife monitoring.

Features	3G/4G LTE	5G
Network Virtualization - making the prototype hardware platform independent and unbundling the software elements to move to the cloud requiring less latency	No	Yes
Adaptable - ability to adjust as per the requirement	No	Yes
AI/ML Powered - providing the processed data developed by self-learning mechanism in real time requires constant and robust connectivity	No	Yes
Swarm Cooperation - efficient and reliable communication of the UAVs with each other	No	Yes

The features listed in Table 2 related to the networking protocols clearly highlight the importance of 5G technology with reference to aspects of adaptability, AI/ML, Virtualisation etc. in any system that is designed for wildlife monitoring. The fan-out of 5G technology i.e., the maximum devices that can be interfaced for robust and speedy operation is large in number. This helps in using a single gateway for a lot of devices on a virtual network to operate without any constraint (Qualcomm Technologies, 2021; Joshi et al. 2020 & Iannnacci 2019). As a result, 5G for wildlife monitoring is essential and should be employed or maintained to examine patterns in animal movement, the habitat use, population changes, occurrences of trapping and poaching of wild animals, and outbreaks of diseases, among other things (Keystone Foundation, 2021; Kabir, R and Lee, K 2021).

4. Conclusion

This paper highlights the popular methods that are present for the wildlife monitoring, and the advantage of integrating 5G with the wildlife monitoring methods. With 5G, unmanned monitoring of wildlife would not be a mere possibility but a reality.The Fifth generation of cellular communication technology will not only promise faster data speeds but also connect innumerable aspects of life using IoT (Internet of things). It would help track animals at real time along with their parameters and aid them if needed. We could reduce the incidences of man animal conflict and prevent poaching. The real time monitoring system aided with drones, camera traps, audio surveillance, etc. would help bolster the security of the conservation parks and forests. It would aid forest rangers in preventing illegal smuggling of animals. Further, it would help in ecosystem conservation with the scientific community getting quick access to data which would mean timely changes in policies for wildlife conservation.

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