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On observing the Animal ecology through Internet of Things (IoT)

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Abstract

It is very tough for an ecologist to understand the behavior of an animal with respect to the environmental changes. However, a framework of sensors net worked together, can help to measure even the slight changes taking place in the environment of a particular area, and thus can help to have a better understanding of the wild life parameters. These networks can even provide a data, helpful in understanding the reasons of mass extinction and thus can help to overcome species loss. This paper has been aimed to highlight the aspects related to present day fate of the conventional detection technology, Introduction of a new technology, Internet of Things (IoT) in ethology and finally the positive and negative sides of this technology. After observing the facts (vide supra), we can conclude that Internet of Things (IoT) offer a better option for understating the animal ecology.

Key words: Animal ecosystem, environmental monitoring, technology. Internet of Things.

Introduction

Animal ecology is the science which dealing with the relationship between animals and their surrounding environment-both biotic and abiotic. Several factors like morphology, physiology, development, population and dynamics behavior including interaction with predators and competitors used to be assessed in order to determine what mechanisms resulting in adaptations of animals to a

particular environment. Presently there are many protocols are still more added in routine basis to ascertain such aspects. On the same aspect is an economic software, hardware as well as database "Internet of Things (IoT)". Data collected with this software may help ecologists working in the ditto field to understand the hazards faced by natural endangered species and ecosystems. This understanding will definitely be helpful in framing comparatively more effective conservation strategies. Here we have

reviewed some frequently used research methods for animal population ecology, and tried to investigate the current and futuristic applications of the “Internet of Things” technology.

Observation of animal ecology through technology:

In the remote past, behavioral patterns of animals were assessed through direct observation and field tracking of an individuals and groups of animals. This approach of studying the animal behavior is still functional in some cases such as in studies related to diurnal animals. However, this approach cannot be considered very genuine as is troublesome for the animals in terms that under the influence of environment with human occupancy they can not behave naturally and this method moreover is also not good for the observer^{7,24}.

Uses of the first commercial cellular networks (1G) date back to early 1980s and were based on analog voice. Further developments in this field resulted in better utilization of the wireless radio resources—resulting in the development of digital voice. Further, Global System for Mobile Communications [(GSM) 2G] came into existence and was broadly accepted. This 2G system got divided two technologies; one General Packet Radio Service (GPRS) and other Enhanced Data rates for Global Evolution (EDGE). GPRS was designed to utilize existing GSM networks and is sometimes referred to as 2.5G, where as EDGE was based on a different modulation technique from GSM which however was having more promising output. Then after development in this field enhanced drastically and now ethologists and ecologists are having so many facilities such as recorders, chips, etc.^{5,11}.

These resources were also used broadly and no doubt are still in use in some case to study the behavior of animals and also to keep surveillance on some, but these techniques are also having some limitations and in some cases also associated with serious complications. For example, data recorders normally remain functional for 1-3 years due to battery life, radio signals on the other hand are sometimes

unreliable, and also harmful to some animals^{16,25}.

In recent years, several new techniques in this filed have been discovered and introduced such as static infra-red cameras. These are used mainly to record the presence and movement of cryptic, nocturnal vertebrates such as jaguars *Panthera onca* and tigers *Panthera tigris*^{3,9,21}. Radio frequency identification (RFID) is also a technique that has been developed for tracking and marking individual animals. RFID is a wireless communication technology that precisely identifies the tagged objects and assists the observer to locate that animal and analyze its activities. RFID is further of two types active and passive. Active tags continuously require a power source such as an integrated battery for its functioning, and emit a signal, but works for a limited time interval. Passive RFID, has long life as is not dependent on battery or other energy source. It is made of mainly three parts: an antenna, a semi-conductor chip attached to the antenna, and some form of encapsulation. Each RFID has a unique identity code, RFID tag, which when attached to animal is analogous to its Identity card but requires some external detector system to observe the subject animal. In one or the other method, there is a great loss of time as well as labors, as well as sometime animals are also disturbed and not useful in all, such as burrowing animals^{6,10,17,18}.

Researchers are now using magnetic induction wireless positioning system using automatic sensor array equipment for such purposes, and getting more appropriate results¹⁵.

The use of IoT in animal ecology can be based on such technologies.

Internet of Things :

Internet of Things (IoT) came into existence mainly in 2005. Internet of Things (IoT) is a broad spectrum system which includes many integrated system to look after the animal diversity in a much systematic and scientific manner. IoT is a combination of information technology, computer science and electronics and telecommunication and many other. In

IoT, sensing networks such as radio frequency identification device (RFID), software, computer systems, camera, GPS system, embedded devices, sensors, etc. are joined and networked, so that the combination turns out into a meaning and valuable device^{8,13,14,23}. Typically, IoT architecture can be categorized into four parts viz. the perceived identification layer, the network construct layer, the management service layer and the integrated application layer²⁰.

Hence, IoT is a network formed from a variety of sensors, which are used as basic detection nodes. The subjects of detection may be a variety of inanimate objects, those associated with living organisms and environmental parameters. The central computing system processes the data sent from the detectors, which are then fed to the effectors or managers for appropriate processing depending on the application⁴.

In some circumstances, IoT has thus been fully applied to the ecology of certain animal species. Because of different research goals and various means of detection, methods to process the data retrieved by sensors, and interaction between those data, the detectors and the effectors, will differ. IoT systems involve the simultaneous use of multiple information engineering technologies applied to ecological principles. These complex networks can be divided into different multi-stage feedback paths.

Briefly, they are processes incorporating signal detection, data processing, and feedback. The physical or chemical data can be obtained by corresponding detectors in the process of detecting signals, and then transferred to the server and processed. Finally, researchers and managers can make judgments as to how best to obtain the optimal data to achieve specific goals. For hardware configuration, the most important components are the detector nodes and the network supporting data transmission. Researchers need to set up these nodes according to specific environmental conditions based on the known ecological information about the animals to be studied.

In accordance with the physiology of the animals to be studied, researchers should use appropriate detectors, such as acoustic, optical or chemical detectors, to record and/or track the target animals. Researchers should take into account the known behavior and/or ecology of the target species to decide the optimal number and the layout of detector nodes to be used (Poter *et al.* 2005). They may discuss how to arrange an IoT network, according to specific research goals, data type and other conditions. The cost of the individual nodes has fallen with the rapid development of data transmission and detector technologies. The transmission of much data over a relatively short time no longer creates a bottleneck within a network deployment due to the development of compression and transmission technologies. Currently, various embeddable detectors can be used as detection nodes in an IoT network (International Tele-communication Union ITU 2005). A network can transfer real-time data from each node and continuously record various environmental parameters.

Internet of Things and the animal ecology :

Currently, various applications of IoT technology have been adopted by the wild life researchers. IoT includes broad array of technologies incorporated together to have a joint network platform for assessing more information from the natural and normal environment of animals. These days the animal under observation has been put a digital identity card and activities of many animals may be analyzed and recorded simultaneously. These technologies also enable the researchers to draw a comparative account of animal species residing presently with those that are lost, thereby helping to find out the causes of extinction. Acoustic sensors and detectors assist researchers to record various calls and gestures of the animals in normal habitats^{1,12}.

These devices, in addition to sending signals about the animals under observation, if enabled also record send the record of surrounding environmental conditions such as temperature, humidity, etc. This

record provides valuable information about the physical and mental state of the animals²².

Advantages and disadvantages of internet of things to the animal ecology research :

The IoT is without any doubt a very good emerging technology as well as industry, and has considerable potential for development with reference to ecological research and the monitoring of wild animals. First, IoT can acquire data continuously, and also adjust the frequency of data collection through remote adjustment of the sensors, which effectively increase the service time of power supplies. Second, IoT can remotely monitor animals and their environment, and, thus, exclude any effects of human interference to record data more objectively. Additionally, a network can function for a long period of time (as opposed to humans) and provide interactive services such as reminders and alerts for users by setting of thresholds on the back-end server by the operator. Finally, after in-stalling the management devices, IoT can implement the interaction with the user under the control of the net-work client, and improve the efficiency of animal monitoring and management. There are some problems in applying IoT, including issues with the short life of batteries, incompatible sensor components and transferring data, particularly large video less¹⁹. However, such disadvantages will be improved with the development of the IT industry: for example, with sensors using new long-life solar energy drive batteries, developing uniform integrated sensor components, and quality of service techniques making the transfer of data more stable². Further IoT application in animal ecology research will require not only the input of IT professionals, but also the design ideas of animal ecologists.

Conclusion and recommendations

IoT will definitely bring a new light of hope in ecological research. But, IoT is still like a “work in

progress” system, requiring further development for its full application to research in animal ecology. Firstly, we recommend that researchers may use this system step by step to reveal the concerned facts related to animal ecology. This may help then to get some thing meaningful, in a systematic manner and also a time gap for then to think of something if unexplored. This thought can also help in further modification of existing system, addition of some new features to the existing ones.

IoT can also be used as a useful tool for wildlife management tool. However, it can be exercised broadly at the lower possible level such as zoo first, to check its applicability and strength.

Future work :

Author of current paper want to implement this technique on the herds of sheep in Himachal Pradesh. For this purpose they are trying to get some funding from government agency to implement IoT system for meaningful purpose.

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