ISSN2394-3777 (Print)
ISSN2394-3785 (Online)
Available online atwww.ijartet.com

International Journal of Advanced Research Trends in Engineering and Technology (IJARTET)
Vol. 5, Special Issue 9, March 2018

IoT TECHNOLOGY, CHALLENGES AND APPLICATION IN AGRICULTURE- A SURVEY

Solaiyammal. K[1]
Assistant Professor
Dept. of Electronics and Communication Engineering,
Idhaya Engineering College for Women, Chinnasalem
Villupuram, 606201, Tamilnadu, India
solaiiecwece@gmail.com

Dhivyapriya. V[2]
Assistant Professor
Dept. of Electronics and Communication Engineering,
Idhaya Engineering College for Women, Chinnasalem
Villupuram, 606201, Tamilnadu, India
dhivipriya8@gmail.com

Abstract-There is a vast enhancement in technologies, different tools and techniques are available in agriculture sector. To improve efficiency, productivity, global market and to reduce human intervention, time and cost there is a need to divert towards new technology named Internet of Things. IoT is the network of devices to transfer the information without human involvement. Hence, to gain high productivity, IoT works in energy with agriculture to obtain smart farming. This paper gives a survey on role of IoT in agriculture that leads to smart farming.

Key Words: Internet Of Things,Challenges, Technology, Applications And Smart Farming.

I. INTRODUCTION

An overview of the Internet of Things (IOT) with emphasis on enabling technologies, protocols and application issues. The Internet of things (IOT) is the inter-networking of physical devices, vehicles (also referred to as "connected devices" and "smart devices"), buildings, and other items embedded with electronics, software, sensors, actuators, and network connectivity that enable these objects to collect and exchange data. The IOT Mainly uses the connectivity of devices system and services that beyond the machine to machine communication. Internet of thing defined the IOT as the infrastructure of the information society.

II. TECHNOLOGIES INVOLVED

There are several technologies that can be used to implement the concept of Internet of Things. In this paper, we discussed the following technologies, Radio Frequency Identification, GPS, Machine-to-Machine, Vehicle-to-Vehicle Communication, RFID Reader, and Internet Protocol.

A) RFID

The RFID is a unique identity of object or person wirelessly using radio waves in the form of numbers. RFID technology plays an important role in IOT for solving identification issues. RFID system is composed of one or more reader and several RFID tags. Tags uses radio-frequency electromagnetic fields to transfer data attached to an object. The tags contain electronically stored information. Passive tags collect energy from a nearby RFID reader's interrogating radio waves. The RFID device serves the same purpose as a bar code or a magnetic strip on the back of a credit card or ATM card; it provides a unique identifier for that object. And, just as a bar code or magnetic strip must be scanned to get the information, the RFID device must be scanned to retrieve the identifying information.

B) RFID Reader

A radio frequency identification reader (RFID reader) is a device used to gather information from an RFID tag, which is used to track individual objects. Radio waves are used to transfer data from the tag to a reader. The RFID tag it must be within the range of an RFID reader, which ranges from 3 to 300 feet.

C) Internet Protocol (IP)

Internet Protocol (IP) is the primary network protocol used on the Internet. The two versions of Internet Protocol (IP) are in use: IPv4 and IPv6.Each version defines an IP address differently. There are five classes of available IP ranges in IPv4: Class A, Class B, Class C, Class D and Class E, while only A, B, and C are commonly used.

D) Wireless Fidelity (Wi-Fi)

Wireless Fidelity (Wi-Fi) is a networking technology that allows computers and other devices to communicate over a wireless signal. Wi-Fi is a technology for wireless local area networking with devices based on the IEEE 802.11 standards. Devices that can use Wi-Fi technology include personal computers, video-game consoles, smart phones, digital cameras, tablet computers, digital audio players and modern printers. Wi-Fi compatible devices can connect to the Internet via a WLAN network and a wireless access point.

e) Machine to machine communication (M2M)

Machine-to-Machine (M2M) refers to the communications between computers, embedded processors, smart sensors, actuators and mobile devices. The use of M2M communication is increasing in the scenario at a fast pace M2M has several applications in various fields like healthcare, smart robots, cyber transportation systems (CTS), manufacturing systems, smart home technologies, and smart grids. Example of M2M area network typically includes personal area network technologies, such as Ultra-wideband and Bluetooth or local networks.

III. ELEMENTS IN IOT

1. **Sensing:** The first step in IOT workflow is gathering information at a "point of activity." This can be information captured by an appliance, a wearable device, a wall mounted control or any number of commonly found devices. The sensing can be biometric, biological, environmental, visual or audible (or all the above). The unique thing in the context of IOT is that the device doing the sensing is not one that typically gathered information in this way. Sensing technology specific to this purpose is required.

2. **Communication**: This is where things start to get interesting. Many of the new IOT devices we are seeing today are not designed for optimal communication with cloud services. IOT devices require a means for transmitting the information sensed at the device level to a Cloud-based service for subsequent processing. This is where the great value inherent in IOT is created. This requires either Wi-Fi or WAN communications.

3. **Data gathering:** Cloud Based Captured data is transmitted to a cloud based service where the information coming in from the IOT device is aggregated with other cloud based data to provide useful information for the end user. The data being consolidated can be information from other internet sources as well as from others subscribing with similar IOT devices.

4. **Delivery of Information**: The last step is delivery of useful information to the end user. That may be a consumer, a commercial or an industrial user. It may also be another device in the M2M workflow. The goal in a consumer use case is to provide the information in as simple and transparent a method as possible.

5. **Semantics:** Semantic in the IOT refers to the ability to extract knowledge smartly by different machines to provide the required services. Knowledge extraction includes discovering and using resources and modeling information.

IV. CHALLENGES

Though IoT delivers an impressive set of benefits, it also presents a significant set of challenges. The IoT promises to bring the connectivity to an earthly level, every home, vehicle, and workplace with smart, internet-connected devices. Some of major challenges are,

a. Privacy: Many IoT applications access personal data but the privacy and protection of personal data may be the one of the major challenge for IoT developers.

b. Security: Iot creates an ecosystem of constantly connected devices communicating over networks. The system offers little control despite any security measures. This leaves users exposed to various kinds of attackers. Increasing the number of different devices that increases security issues.

c. Connectivity: Variety of wired and wireless connectivity standards are required to enable different application needs.

d. Scalability: Size of the systems tends to large in size, the solutions should be scalable. Also any times the deployments happen in stages and the architecture should be able to scale up incrementally without taking too much overhead.

e. Flexibility: Many are concerned about the flexibility of an IoT system to integrate easily with another. They worry about finding themselves with several conflicting or locked systems.

f. Complexity: The IoT is diverse and complex network. Any failure or bugs in the software or hardware will have serious consequences. Even power failure can cause a lot of inconvenience.

g. Wireless communications: When we come to energy point, wireless technologies such as GSM, UMTS, Wi-Fi and Bluetooth are far less suitable. Many recent WPAN trends as Zig Bee and other still under development they have narrow band width and consume less energy.

V. APPLICATIONS OF IOT

A. Smart parking

The new Smart Parking sensor's or switches to be buried in parking spaces to detect the arrival and departure of vehicles. The Smart parking provides extensive parking management solutions which helps motorists save time and fuel.

B. Smart Home

Smart Home clearly stands out, ranking as highest Internet of Things application on all measured channels. We are surrounded by various electronic gadgets around us such as microwave ovens, refrigerators, heaters, air conditioners, fan and lights. Actuators and sensors can be installed in these devices in order to utilize the energy sufficiently and also to add more comfort in life. These sensors can measure the outside temperature.

C. Smart City

Smart city spans a wide variety of use cases, from traffic management to water distribution, to waste management, urban security and environmental monitoring. Its popularity is fueled by the fact that many Smart City solutions promise to alleviate real pains of people living in cities these days. IOT solutions in the area of Smart City solve traffic congestion problems, reduce noise and pollution and help make cities safer.

D. Health

ISSN2394-3777 (Print)
ISSN2394-3785 (Online)
Available online atwww.ijartet.com

International Journal of Advanced Research Trends in Engineering and Technology (IJARTET)
Vol. 5, Special Issue 9, March 2018

It can gather information about health and send the collective data to health monitoring center. These centers can, therefore, analyze health and provide the valuable report and information to the individual.

E. Smart Cars

Machine to machine (M2M) communications, and especially Smart Cars, could help to improve accident prevention. These driverless cars will provide functioning more than just safety such as they can save valuable time, reduce stress of driving etc.

F. Smart Water Supply

Smart cities must monitor water supply to ensure that there is adequate access for resident and business need. Wireless Sensor Networks provide the technology for cities to monitor their water piping systems more accurately and discover their greatest water loss risks. Cities that are addressing water leakage problem with sensor technology are producing high savings from their investment.

The IoT technology is more efficient due to following reasons:

1. Global Connectivity through any devices.
2. Minimum human efforts
3. Faster Access
4. Time Efficiency
5. Efficient Communication

VI. SMART AGRICULTURE USING IOT

Agriculture is the main backbone of India's Economical growth. The most important barrier that arises in traditional farming is climatic change. The number of effects of climatic change includes heavy rainfall, most intense storm and heat waves, less rainfall etc. Due to these the productivity decreases to major extent. Climatic change also raises the environmental consequences such as seasonal changes in life cycle of plants. To boost the productivity and minimize the barriers in agriculture field, there is need to use innovative technology and techniques called Internet of Things. Today, the Internet of Things (IoT) is transforming towards agriculture industry and enabling farmers to compete with the enormous challenges they face. Farmers can get huge information and knowledge about recent trends and technology using IoT.

advancement in the Iot technology will help farmers increase the crop gain. As Iot application in agriculture continues to develop, farms will become more connected more streamlined, more efficient and ultimately more productive. Internet of Things will effectively solve the quality and safety problems of agricultural Products. The important applications of IoT in agriculture are water quality monitoring, monitor soil constituent, water irrigation and pest monitoring and is shown in (Figure 1).

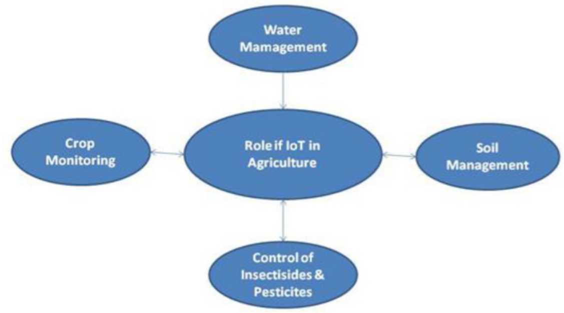

Fig 1. The idea of Agriculture IoT

This idea germinates from the smartness notion given by technologies like Internet of Things, Big Data and Cloud computing etc. Agriculture IoT can be seen as a network of sensors, cameras and devices which will work towards a common goal of helping a farmer do his job in an intelligent manner. These devices will be self-sufficient in a way that they will not need human interference to communicate with each other. In other words, the devices are equipped with the intelligence of knowing the time and reasons for interacting with other devices in the system.

IOT Elements in agriculture

The sensors and cameras are mainly used to collect data about the weather conditions, soil's moisture and nutrient contents, images of crops to detect pest attacks and the onset of diseases, controlling the greenhouse environments, animal husbandry supervision and control, food transportation and marketing etc. These are sensors which are used for monitoring orchards and fields through data collected by them. This data is used for effective pest control and field management.

The main ideas are summarized below:

- Monitoring the fields in a more scientific way by collecting data through sensors and devices
- Help in smart management of fields and greenhouses with respect to watering needs, pest Control etc.
- Help achieve higher yields of crops along with enhancing their quality
- Better disaster control through prior information and alerts.
- Help improvise the whole supply chain from farmers to the market.
- Effective supervision of animal husbandry

Working Of IOT in Agriculture

The whole process revolves around the collection of data for use by the farmers and other Stakeholders. This is the most crucial part of its working. The devices used range from sensors to cameras and satellite images. The second part

ISSN2394-3777 (Print)
ISSN2394-3785 (Online)
Available online atwww.ijartet.com

International Journal of Advanced Research Trends in Engineering and Technology (IJARTET)
Vol. 5, Special Issue 9, March 2018

consists of the network which will help transfer the data generated by the devices as mentioned earlier. Different types of network technologies like GSM, LTE, Wi-Fi, 3G etc. may be used depending upon the availability and requirements. The third part consists of data collection and computing technology like the Cloud services. The cloud servers can be made available independent of the locations and hence most suitable for IOT type of systems.

The data can be stored and computed upon on such servers. The cloud services can be taken on a pay-per-use policy as they are becoming popular for this reason. The last part of the system will be the Big Data analytics tools which can work on the vast amount of data generated and stored on the cloud servers, to excavate important patters and trends in the data. For example, weather predictions and market analysis can be done using such tools

The selection of an appropriate network technology and infrastructure is also an important issue. The network which provides good speed, lesser energy requirements and supports more number of devices per access point will be the apt choice. Infrastructural requirements in terms of access points, smart devices, network facility, participation of local government and imparting education and awareness among the users has to be considered by the government.

Zigbee based Agricultural Monitoring and Controlling System.

The user interface components of Zigbee based agricultural parameters monitoring and controlling system. The main components are the search bar, zooming options, panning options, and zoom level indicator, which are discussed below. Indonesian agriculture has great potential for development. Agriculture a lot yet based on data collection for soil or plant, data soil can use for analysis of soil fertility. We propose e-agriculture system for monitoring soil. This system can monitor soil status. Monitoring system based on wireless sensor node that sensing soil status. Sensor monitoring used soil moisture, humidity and temperature. System monitoring design with sensor node is based on microcontroller and xbee connection.

Data sensing send to gateway with star topology. Gateway is used in computer and connects to xbee coordinator mode. The system can help famer for monitoring soil and farmer can making decision for treatment soil based on data. It can improve the quality in agricultural production and would decrease the management and farming costs. Today, Ethernet network, RF module and ZigBee wireless network are used to transmit data in remote Monitoring System. This paper gives a review of remote control and monitoring systems based on existing technologies and ZigBee based sensor node control and monitoring system with automatic irrigation system is proposed. The design presented has the advantage of ZigBee technology. The proposed hardware of this system includes Arduino microcontroller, zigbee module, Temperature, humidity and soil moisture sensors, LDR Sensor, Ultrasonic Sensor. The system is low cost and low power consuming so that anybody can afford it. The data monitored is collected at the server. It can be used in precision farming. The system should be designed in such a way that even illiterate villagers can operate it. They themselves can check different parameters of the soil like moisture etc. from time to time. In this system LDR sensor is used tp detect the presence of light. If light is not preset at night then automatically lamp is on. Ultrasonic Sensor is also used which measure the height of the Plant. At receiver side ZigBee come into picture. There is only one Tx and Rx pins Signal is send to microcontroller and parameters like temperature, soil moisture and humidity are monitored. These parameters are monitored on computer using USB to TTL converter. This data can be used for precision farming [3].

VII. BENEFITS AND FUTURE ENHANCEMENTS

The agriculture is getting automated day by day by simplifying the work of farmers and optimizing the crop production. On the IOT in agriculture works by collecting information from soil, humid level, and temperature monitoring is easy and can be done in a regular basis which is helpful in predicting the ecological factors. The Mari culture can also be improved in this scenario. IoT together with cloud can improve the efficiency of country's production. Since water scarcity is becoming high, using this system the water is highly conserved.

From the above information collected from various researches the work can be further extended in two broad ways. (i) Few parameters such as reliability, scalability can be improved and the open source programming languages such as R and python could be used as a program. The development of smart Irrigation system could be implemented in other plantations such as citrus crops and analyzing the performance. The data set can be still increased to improve the accuracy of the system In authentication scheme further complexities of the protocol are reduced without compromising security features. The entire work can be even merged with cloud computing environment.

The key advantages of using IoT in enhancing farming are as follows:

1. Water management can be efficiently done using IoT with no wastage of water using sensors.
2. IoT helps to continuous monitor the land so that precautions can be taken at early stage.
3. It increases productivity, reduce manual work, reduce time and makes farming more efficient.

ISSN2394-3777 (Print)
ISSN2394-3785 (Online)
Available online atwww.ijartet.com
International Journal of Advanced Research Trends in Engineering and Technology (IJARTET)
Vol. 5, Special Issue 9, March 2018

4. Crop monitoring can be easily done to observe the growth of crop .
5. Soil management such as PH level, Moisture content etc can be identified easily so that farmer can sown seeds according to soil level.
6. Sensors and RFID chips aids to recognize the diseases occurred in plants and crops. RFID tags send the EPC (information) to the reader and are shared across the internet. The farmer or scientist can access this information from a remote place and take necessary actions; automatically crops can be protected from coming diseases [1].
7. Crop sales will be increased in global market. Farmer can easily connected to the global market without restriction of any geographical area.

For instance, the system proposed in Zou (2014) is used for online crop growth monitoring and it captures different types of variables such as temperature, humidity, soil moisture, CO_2, luminosity, pH of water, and images [2]. Some representative examples of IoT applications categorized in the monitoring domain are described below.

Air monitoring: this sub domain aimed to provide periodic or continuous measurements, evaluating and determining environmental parameters or pollution levels in order to prevent negative and damaging effects. It also included the forecasting of possible changes in the ecosystem or the biosphere as a whole. For instance, in Watthanawisuth et al. (2009) authors

described an agricultural IoT solution which can be categorized in the air monitoring sub-domain [3]. In this solution, authors proposed a real-time monitoring system of microclimate based on a WSN. The solution included temperature and relative humidity sensors (SHT15) powered by solar panels and supported by ZigBee communication technology. Another air monitoring IoT solution is GEMS (Lu et al., 2010), which proposed an environmental monitoring system based on GPRS technology for monitoring apple orchards [4]. This system was tested in five different regions of China over a 2-year period by monitoring variables such as relative humidity, temperature, and radiation.

Soil monitoring: papers classified in this subdomain such as (Chen et al., 2014) proposed systems for monitoring multi-layer soil temperature and moisture in a farmland fields using WSN [5]. These systems are supported by communication technologies such as ZigBee, GPRS, and Internet, where user interaction with the system is handled by a web application.

Water monitoring: primary studies categorized in this subdomain intend to monitor water pollution or water quality by sensing chemicals, pH, and temperature, which can alter the natural state of water. An example of this subdomain is presented in Postolache et al. (2013) [22], where authors proposed an IoT solution for water quality assessment through the measurement of conductivity, temperature, and turbidity. The solution is based on a WSN architecture that combines low-cost sensing devices and monitoring of multiple parameters of water quality of shallow waters (lakes, estuaries, rivers) in urban areas. Similarly, (Xijun et al., 2009) proposed a WSN system for monitoring water level and rainfall in irrigation systems [23].

Plant monitoring: The LOFAR-agro Project (Langendoen et al., 2006) is an example of the plant or crop monitoring [24]. This project aimed to protect a potato crop against Phytophthora (a genus of water mold) by monitoring the microclimate (humidity and temperature) using a largescale WSN. The system intended to generate a policy to protect the crop against the fungal disease based on the collected data. In Fourati et al. (2014), authors propose a Web-based decision support system communicating with a WSN for irrigation scheduling in olive fields [25]. For this purpose, authors use sensors to measure humidity, solar radiation, temperature, and rain.

Animal monitoring: This subdomain referred to animal tracking for both wildlife and animal husbandry activities. A research belonging to this subdomain was a delay-tolerant WSN for the monitoring and tracking of six horses presented in Ehsan et al. (2012) [26]. For this purpose, authors developed necklaces that acquired information about horses' position and speed at a given time and transmitted such logs to fixed nodes when they were close to its coverage area.

Another example of animal monitoring was given by Jain et al. (2008) [27], where an IoT solution was responsible for monitoring the behavior and migration patterns of Swamp Deers, obtaining information of the animal position and the climate at the same time.

Unlike monitoring domain applications, which handle information in one-way, applications categorized in control use a two-way information channel. This means that a new level of communication was added, and commands could be sent back to the field. In this case, information from the server or data center traveled to a Wireless Sensor and Actuator Network (WSAN) in order to control a set of actuator devices to modify the state of the process or environment. Commands were sent through a human–computer interface or as a result of a decision algorithm supported by analytic modules. Actuator devices included valves, pumps, humidifiers, and alarms among others. Many of these systems aimed to optimize the usage of water, fertilizers, and pesticides based on information provided by weather prediction systems and on-site WSN. Solutions in this domain could help farmers to reduce water consumption and waste by scheduling irrigation times and quantities according to the state of the crop and its growth cycle. Control systems were programmed to be adaptive, for instance, switching off sprinkler if rain was detected. Overall, solutions with control systems could save

ISSN2394-3777 (Print)
ISSN2394-3785 (Online)
Available online atwww.ijartet.com

International Journal of Advanced Research Trends in Engineering and Technology (IJARTET)
Vol. 5, Special Issue 9, March 2018

money to the farmer and provide at the same time valuable insights about the consumption of water, fertilizers, Pesticides and electricity.

VI. CONCLUSION

IoT works in different domains of farming to improve time efficiency, water management, crop monitoring, soil management, control of insecticides and pesticides etc. It also minimizes human efforts, simplifies techniques of farming and helps to gain smart farming. Zigbee-based agriculture monitoring system serves as a reliable and efficient system for efficiently monitoring of the environmental parameters. The System is designed for the betterment of farmers. The uses of smart sensor based monitoring system for agriculture have been used to increase the yield of crop by monitoring the environmental conditions and providing information to observer. It would be a promising technology for the agriculturists all over the world in the present scenario of unpredicted parameters.

REFERENCE

[1] Mamishev AV, Sundara-Rajan K, Yang F, Du Y, Zahn M. “Interdigital sensors and transducers,” Proc. IEEE. 2004;92(5): 808-45

[2] P Parhana*, MV Lakshmaiah, S Allaudheen, S Dastagiri, M Vijaya Saritha Review on Internet of Things: Recent Applications and its Challenges IJAREEIE, Vol. 6, Issue 11, November 2017.

[3] K.R.Sarode, Dr. P.P.Chaudhari, *Zigbee based Agricultural Monitoring and Controlling System*. International Journal of Engineering Science and Computing, January 2018

[4] Karandeep Kaur, The Agriculture Internet of Things: A review of the concepts and implications of implementation. International Journal of Recent Trends in Engineering & Research (IJRTER) *Volume 02, Issue 04; April - 2016 [ISSN: 2455-1457*]

[5] Vinayak.N . Malavade , Pooja.K, Role of IOT in agriculture. *IOSR Journal of Computer Engineering (IOSR-JCE) e-ISSN: 2278-0661,p-ISSN: 2278-8727*

[6] Pharmacogn J. 2018; 10(2):260-264, A. Srilakshmi, Jeyasheela Rakkini, K. R. Sekar, R. Manikandan , A Comparative Study on Internet of Things (IoT) and its Applications in Smart Agriculture.

[7] Deeksha Jain, P. Venkata Krishna and V. Saritha, “A Study on Internet of Things based Applications”, 2012.

[8] Zou, C.-J., 2014. Research and implementation of agricultural environment monitoring based on internet of things. In: 5th International Conference on Intelligent Systems Design and Engineering Applications (ISDEA). IEEE, pp. 748–752.

[9] Watthanawisuth, N., Tuantranont, A., Kerdcharoen, T., 2009. Microclimate real-time monitoring based on zigbee sensor network. In: Sensors. IEEE, pp. 1814–1818.

[10] Lu, S., Duan, M., Zhao, P., Lang, Y., Huang, X., 2010. GPRS-based environment monitoring system and its application in apple production.
International Conference on Progress in Informatics and Computing (PIC), vol. 1. IEEE, pp. 486–490.

[11] Chen, K.T., Zhang, H.H., Wu, T.T., Hu, J., Zhai, C.Y., Wang, D., 2014. Design of monitoring system for multilayer soil temperature and moisture based on WSN. In: International Conference on Wireless Communication and Sensor Network (WCSN). IEEE, Wuhan, pp. 425–430.

[12] Postolache, O., Pereira, M., Gir ao, P., 2013. Sensor network for environment monitoring: water quality case study. In: 4th Symposium on
Environmental Instrumentation and Measurements, pp. 30–34.

[13] Xijun, Y., Limei, L., Lizhong, X., 2009. The application of wireless sensor network in the irrigation area automatic system. In: International Conference on Networks Security, Wireless Communications and Trusted Computing (NSWCTC), vol. 1. IEEE, pp. 21–24

[14] Langendoen, K., Baggio, A., Visser, O., 2006. Murphy loves potatoes experiences from a pilot sensor network deployment in precision
agriculture. 20th International Parallel and Distributed Processing Symposium (IPDPS), vol. 2006. IEEE, Rhodes Island, pp. 1530–2075.

[15] Fourati, M.A., Chebbi, W., Kamoun, A., 2014. Development of a web-based weather station for irrigation scheduling. In: 3rd International Colloquium in Information Science and Technology (CIST). IEEE, pp. 37–42.

ISSN2394-3777 (Print)
ISSN2394-3785 (Online)
Available online atwww.ijartet.com

International Journal of Advanced Research Trends in Engineering and Technology (IJARTET)
Vol. 5, Special Issue 9, March 2018

[16] Ehsan, S., Bradford, K., Brugger, M., Hamdaoui, B., Kovchegov, Y., Johnson, D., Louhaichi, M., 2012. Design and analysis of delay-tolerant sensor networks for monitoring and tracking free-roaming animals. IEEE Trans. Wireless Commun. 11, pp. 1220–1227.

[17] Jain, V.R., Bagree, R., Kumar, A., Ranjan, P., 2008. wildCENSE: GPS based animal tracking system. In: International Conference on Intelligent Sensors, Sensor Networks and Information Processing (ISSNIP), pp. 617–622. http://dx.doi.org/10.1109/ISSNIP.2008.4762058.

