Forest Monitoring Using Remote Sensing

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Abstract

Due to sudden climatic changes we are facing natural disasters every now and then. Floods and Forest fire news are always hitting the headline of newspapers. Recently Brazil and Australia have been affected by Forest Fire. There is also increase in illegal activities such as Poaching, Deforestation etc. which lead to attack by animals in nearby areas. The Forest Rangers are not able to monitor the forest covers due to lack of accessories and resources. Therefore, we decided to study various Forest Monitoring System. In this system we will monitor the forest using various Remote Sensing techniques.

Keywords— Forest Monitoring System, Deforestation, Remote Sensing, Poaching, Forest Rangers, Forest Fire.

I. INTRODUCTION

Forest play an important role for supporting humankind and harm to forest will result in harm to our self and environment. The protection of wildlife is also important for maintaining ecosystem. The biggest threat to forest nowadays is either intruder or Fire. Intruders enter forest and perform various illegal activities such as poaching, deforestation, exploitation etc. due to sudden climatic changes there is lot of cases of Forest fire coming up which can destroy large portion of Forest and can affect the ecosystem of that region. So to overcome above problems use of Forest Monitoring System is done. Using Forest Monitoring System, we not only look after the trees or plant but also look after illegal activities by the intruder and Forest fire.

The measurement of chemical, physical, biological parameters of forest and observing the changes over period is called Forest Monitoring. Whereas, Remote Sensing is called as the process in which we collect an information about objects, areas from distance. From last decade it has been observed that due to global warming, change in climatic conditions; the nature has been affected the most. There is also increase in illegal activities, sudden rise in temperature leading to Forest Fires. To ensure safety of Forest region across the world various Forest Monitoring System are made.

This paper focuses on the study of various Forest Monitoring Systems proposed in various papers and various drawbacks in the current models, future scope of the building of System. This paper is structured as follows Section II gives brief study of the various methods proposed by various authors. Section III tells about the information of the topic and benefits forest can get using Monitoring System. Section IV discusses the Challenges and Future Scope of the Forest Monitoring System.

II. LITERATURE REVIEW

We have done study of 10 papers which had focused on various proposed Forest Monitoring System using Remote Sensing. Below shows the briefing of various papers.

Y. Deshpande, K. Savla, C. Lobo, S. Bhattacharjee and J. Patel (2018) [1] proposed a system in which we can look after the animal activities and illegal human activities inside forest region. The authors proposed a system using NodeMCU, various sensors. The DHT-11 sensor will collect data of humidity and temperature. Thermal Imaging Cameras Sensor captures the heat photographs of things and convert it in images. The Infrared Sensors captures the emitted signals which are reflected by the objects in Forest. Ultrasonic Sensors captures the ultrasonic frequencies coming from objects. This all the sensors collects the data and then transferred to NodeMCU. The data is then sent by NodeMCU to in-built ESP8266 Wi-Fi Module, the data is sent wirelessly to ESP8266 Wi-Fi. The ultrasonic Sensors and Thermal Imaging Sensors both are mounted on Servo motor which rotates 180 degree for capturing any illegal activities around the border. If any illegal activities, moving of animals out of forest have been detected then it sends the data directly on Twitter for informing forest officials. The

advantages of this system is that it runs on solar cells and transmission of data is wireless throughout the network. The report is directly posted on Twitter handle. This system has also few disadvantages such as taking animal count is hard and inaccurate. If the area to monitor is large more powerful batteries are required.

W. Fengbo, L. Xitong and Z. Huike (2018) [2] estimated a system in which we can detect forest fire. The system consists of three parts: data acquisition node, monitoring terminal, environmental monitoring data server. There are many data acquisition node placed at different location which collect data related temperature and humidity, flame, light intensity, smoke using various sensors. The collected data is sent via Zigbee Network to monitoring terminal. The authors of this method had used CC2530 processor for data acquisition node as it has less power consumption, fast processing of data and support Zigbee transmission. The monitoring terminal is central part of the system, it is used to process and analyse the data sent by acquisition nodes. STM32 is used as monitoring terminal.STM32 has features like high performance, low power consumption and las low-cost embedded applications. Zigbee module accumulates the data sent by acquisition nodes and send to SMT32 for processing and analysing the data. The data is then sent to environmental monitoring server using GPRS data transmission. The data server is main part for analysis of data. The server consists of two sub-homepages: one for data collection and another for alarm information. It provides the alarming data to Forest Rangers using sub-home pages. The advantages of this studied system are; it gives real time result of Forest fire and it is suitable for forest where power supply is difficult. The system is made efficient by using Zigbee and GPRS for transmission of data. The system is not cost efficient as compared to other systems.

Y. Wang and G. Dang (2018) [3] estimated a Forest Fire Monitoring System which predict real time forest fire and increases the efficiency of wireless sensor network. For detection of fire; moisture content of combustible substances is checked by this system. Using Sensor nodes, the temperature and humidity of combustible substances present in air is measured. The collected data is then transmitted to network coordination point then to central control room where the signal is seen by the forest officials. The transmission is done using 4G network. In this paper also Zigbee wireless network is used as its implementation cost is low. To solve the problem of large forest area and to increase network life cycle an algorithm is used to detect abnormal areas to reduce data collection and to save energy of network. The advantage of this system is it uses an algorithm for increasing efficiency of transmission. During the study by authors it was found that there might be case where there is repeated coverage of some areas due to which there is occurrence of blind area. This is occurred due to uneven distribution of sensors.

V. Sherstjuk, M. Zharikova and I. Sokol (2018) [4] proposed a system in which there is a group of UAVs (Unmanned Aerial Vehicle) to fight the Forest Fire using remote sensing techniques. This system has three main functions i.e., detection of fire, monitoring fire, fire prevention. The group of UAVs is used to locate the fire using sensors and providing adequate data so that the same or other group of UAVs can e used to prevent the fire. This UAVs are equipped with various firefighting tools. This paper presents a way to fight the fire during its early detection. The whole system proposed here is autonomous and has good scope in future. The main disadvantage of this system is that error in location can cause loss of fire fighting resources and increase on fire.

K. A. Othman, M. A. H. M. Isa, M. A. Baharuddin, M. A. Ghazali, Z. I. Khan and N. A. Zakaria (2018) [5] presented a system which give real time monitoring of Forest using sensors with Visual Basics and android application. The hardware parts used are Arduino Nano Controller, Motion detector, Infrared Camera and GPS Module. The Sensors are placed at a location of forest and using motion detector and infrared cameras various animals, objects pictures are captured and using GPS module location is also sent to user. The images which we receive are raw, so they are converted using Visual .Net Programming. All the images are stored in MySQL database and android application is used to increase user viewing and data accessibility. The main advantage of this system is that we can place various hardware module at various location; mostly near the border of forest so

that if any illegal movement of human or animal movement outside the forest can be captured and necessary action could be taken. The disadvantage of this system is convenient only if forest region is small. The cost of system increases if more hardware component is required.

A. Marcu, G. Suciu, E. Olteanu, D. Miu, A. Drosu and I. Marcu (2019) [6] the authors estimated a Forest monitoring system using Raspberry Pi Model 3, analog and digital signal and signal analysis algorithm. Temperature, soil humidity, gas concentration is monitored using sensors. This proposed system analyses the background sound using classification algorithm. This algorithm classify sound into following categories: vehicle sound, forest noise, chainsaw sound. This paper focuses on chainsaw sound and if collected sound data resembles chainsaw then necessary action is taken by sending data to user. The data is sent to user which can be accessed using mobile application. This application also give notification of any illegal deforestation or alarm about Forest fire if any case is found by system. For detection of Forest fire; the CO gas concentration is measured along with temperature. If CO gas concentration increases, then temperature also increases which lead to fire. The advantage of this proposed system is sound plays an important role for detection of illegal activities but also other factors like sound of vehicle is not considered by this proposed method.

S. Rizanov, A. Stoynova and D. Todorov (2019) [7] the author proposed an autonomous system for early detection of Forest fire and monitoring it. The proposed system consists of four components: the measuring Node called LoRa (Long Range Radio) Node, HUBs-LoRa Gateways, Central Server, PC for connection and accessing data of Server. The Node will collect data for various parameters using embedded sensory block. The sensors will measure humidity and temperature of the surroundings, concentration of carbon dioxide, carbon monoxide and formaldehyde in ppm respectively. The Node then reads the measured data using embedded CPU and make data packets of measured data and sends to Gateway using communication channel after every defined time interval. The data packets also contain the location and timestamp of the data which is measured. The Gateway collects the data from nodes which are close to itself and send it to Central Server using GPRS/3G/4G or NB-IoT communication channel. The received data is stored in Server and monitored regularly and checks any uneven change in data of parameter to taking certain action.

A. Tufa, I. Boicu, I. Filip, C. Negru and F. Pop (2018) [8] proposes a system using remote sensing computational model in cloud used for monitoring forest. Satellite images of forest plays an important role in whole system as it is used as source for monitoring forest. The authors have also studied performance of various current technologies and its efficiency in storage management, system scaling, automatic deployment etc. The system also improves existing algorithms for satellite images. The images from satellite is processed and sent to cloud system, where various algorithm is used for processing the images and converting into geographical sub-forest. The monitoring system requires measurement of temperature, humidity, wind speed etc. which is done by considering a sub-forest and measurement of that sub-forest is done. The advantage of this system is that for data storage Cloud system is used but the data collected from satellite might not be in real time.

G. Georgiades, X. S. Papageorgiou and S. G. Loizou (2019) [9] proposed a system which uses optical and thermal camera attached on UAV (Unmanned Aerial Vehicle) and static cameras. The system provides autonomous early detection of fire. The system consists of static cameras equipped with various sensors; this camera monitors the specific areas where it has been installed. It also checks for environmental condition such as temperature, wind speed, wind direction etc. to check whether UAV can be able to make a flight or not. All the data collected by sensors are combined and check for risk assessment operation. If the risk parameter goes above threshold then forest authorities get notified through SMS or email. If data is not sufficient to calculate risk factor, then UAV which are equipped with thermal cameras are sent over location to capture images and provide adequate data. The collected data is then again iterated with previous data and risk factor is calculated. The advantage of this system is that at every step authority get notified about the result.

R. Raj, S. Michael and D. Femi (2019) [10] proposed a system which detect the intruders using Image Processing and RFID technology. In this system static cameras with solar cells are installed which detects human using algorithm provided by TensorFlow. After detection of human it captures photograph and sends to RFID technology to check whether the human is forest official or not. Every forest person is having unique RFID tag. So, if the tag is not found then system assume it as intruder. The system captures the photograph and process it by combining with intruder's location inside forest and sending the data to Forest officials via GSM module. The picture can be seen through web application or mobile application.
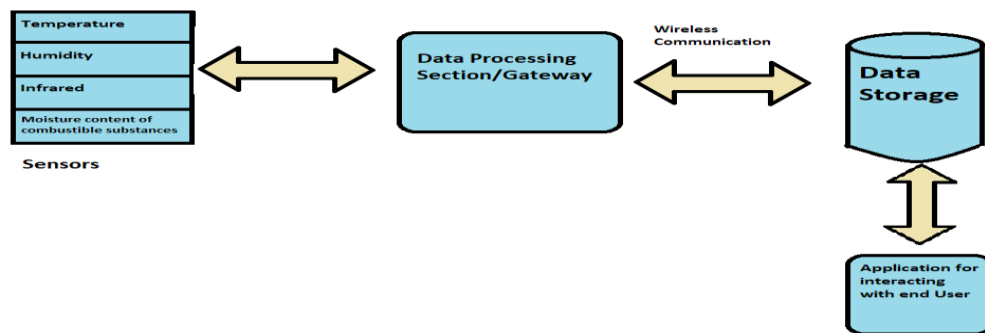
III. FOREST MONITORING SYSTEM

FIG. 1 BLOCK DIAGRAM OF FOREST MONITORING SYSTEM

From the study of 10 papers we observed one common feature in all the proposed methods that for developing a large system wireless communication is always preferred. Basically, most of the system consist of three parts: data collection, data processing and data storage and display[11]. In Data collection section we collect the data of environment using various sensors and send it to next section using any wireless transmission. In Data processing, the actual data sent by data collection facility is processed and various algorithm is applied to send data to next section efficiently using wireless communication. In the last stage i.e. Data Storage and Display the collected data is stored securely and if any alarm is to be given to Forest officials then it is displayed using any one from web application, mobile application, email, SMS etc. so necessary action can be taken. Fig .1 shows basic block diagram of Forest Monitoring System.

Forest Monitoring System is very beneficial for Forest and its natural habitat. Human beings will be protected from animal as animals are under constant observations. In many countries illegal activities operate from Forest region and to locate such activities UAV can be used which will help the police personnel to locate and perform necessary actions[12 13]. Using Forest Monitoring System, we can get real time information about the forest fire and could be tackled before it spread to other parts of forest. Forest Monitoring System is a boon for Forest Rangers.

IV. CHALLENGES AND FUTURE SCOPE

The system proposed by various studies was well but they all lack in some monitoring aspect of Forest:

1. Using UAV (Unmanned Aerial Vehicle) for counting of animal is very confusing and inaccurate.
2. Repeated coverage of same area can cause distortion in result leading to blind area.
3. In autonomous Forest Monitoring System there might be case where the location of fire in the forest might be wrong due to which automatic fire fighting modules might act on wrong area due to which there is wastage in firefighting resources.
4. In various studies we found that static camera was used; for larger area to be monitored more cameras will be required resulting in increase in cost of the system.

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5. Most of the studies used solar cell as source of battery but for larger application more efficient batteries are needed and using more solar cells would lead to increase in cost of system.

There is a good scope for the Forest Monitoring System in the future:
1. Security to the data can be improved
2. A fully automatic system capable of detection of fire along with extinguishing it.
3. Identification of endangered species.
4. Continuous tracking of animals which came outside of forest.
5. Detection of weapons and militants.
6. Capable of monitoring forest in large area.

V. CONCLUSION

The use of Forest Monitoring System will increase in the future as forest fire and illegal activities inside the forest has been increased. The existing systems are efficient, but they do lack in few aspects such as security of data, high set up cost, repeated coverage.

In this paper, we carried out a survey on various Forest Monitoring Systems, its working, advantages and disadvantages, usage of sensors, how transmission of data is done, and we concluded that using of static cameras equipped with sensors along with UAV provide good monitoring results. Based on our knowledge, we provided insights on different challenging areas while implementing a system and scope of research was also explored.

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