Smart Fog Based Deforestation Detection System

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Abstract

Forests plays a vital role in the environment sustainability. There are the sources of essential resources day-to-day basis. They provide food, livelihood, nutrition, clean air and protect us from natural disasters. Despite of such importance, forests are exploited and misused with illegal means such as deforestation for fulfillment of agricultural or wood demands for human urbanization. Internet of things are playing a very major role in many smart applications such as smart homes, smart agriculture, smart grid and smart transportation. Basic aim is to ease the human daily life. Here, an IoT device smart drone-based technology solution has been proposed for deforestation issue. Researchers have conceptualized the drone technology which is going to capture the field images for detection of any missing tree due to illegal human intervention. In this paper, we have proposed a solution for deforestation using iFoGSim simulator environment.

Keywords

Fog Computing, Drones, Sustainability, iFoGSim, Smart green technology

1. Introduction

Many smart internet of thing devices are connected to each other across the world producing huge amount of data. Due to wide internet connectivity, these devices are applied into many of the application area such as smart healthcare, smart buildings, smart homes and smart transport. Initially cloud was integrated with the IoT devices because of their less computation power and less storage capabilities[1]. However, as the demand is continuously increasing leading to some potential challenges for cloud to manage and accommodate such huge number of requests. Such challenges are prominent for time or delay sensitive applications such as a lifesaving application based in healthcare, fire control and management or traffic management[2].

FoG computing was discovered by CISCO In 2011 which has been introduced as a middle layer between cloud and IoT[3]. FoG layer contains fog nodes or devices having little computational and storage capabilities which can reduce the load on the cloud thus overcoming the limitation. It has been observed that with the usage of Fog layer efficient results has been obtained. FoG computing does the processing part closer to edge making it efficient in terms of energy, latency and network utilization. Though fog devices are having less computational capabilities when compared to the cloud. Therefore, an integrated model of IoT-FoG-Cloud is followed to do the processing of data and produce the results[4].

In this paper, an implementation scenario is considered towards sustainability. Deforestation has become a bottleneck for environment protection. So, here deforestation issue has been addressed and simulation of scenario is done by keeping a track if in case any tree is cut and a notification can be generated to the nearby forest department[5]. The administrative people can take a proper action timely and protection of environment can be done. As we all know that human life expectancy is based on the environmental conditions. Thus, this paper has addressed the issue of deforestation as well as effect of the same on human expectancy [6].

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Our contribution in this paper is as follows:

- The whole scenario has been simulated in the iFoGSim simulator.
- Parameters such as energy consumption, total network usage, execution time, cost of execution in cloud are analyzed.

The remaining part of this paper has been organized as follows:

- Section 2 discusses the challenges faced by forest department in the conservation of ecosystem.
- Section 3 discusses the installation and Setup of the simulator with complete case study of implementation of deforestation with parameter explanation.

Section 4 contains the conclusion and future research directions for this field.

2. Challenges Faced by Forestry Towards Sustainability

Deforestation has made a huge adverse impact on the loss of vegetation, climate change, loss of wildlife, atmospheric pollution, biodiversity, greenhouse gas emission, floods, global warming. The list is quite long and huge making an impact on human expectancy life as well as natural resources gradually[7,8,9]. Few of the challenges faced by forestry are as follows:

2.1. Large Surveillance Forest Fields

As we know there are large forest fields making it a troublesome task to do the complete surveillance. It requires a large number of people and workforce working in a continuous manner with appropriate resources[10]. As a relief, an aerial surveillance can be accommodated with the help of Unmanned Aerial Vehicles (UAVs). They can be used for aerial photography, mapping, thermal imagery and monitoring[11].

2.2. Human Life Loss

Threating situations can be generated in forests at any point of time which make it very challenging to prevent human life loss. As a means of relief, Drones are helpful in such situations where they can provide the information timely with no human life threat[12].

2.3. Preservation of Natural Resources

As natural resources are basis of existence of human life, without them human race will extinct making it of utmost importance. Problem of fresh air has been severely increased in past few years because of deforestation or illegal cut of trees making it one of the challenges[13,14].

2.4. Climate Change

It has been observed that climate conditions have been changed over the past few years. In general, a rise of 4-5 degrees has been recorded in almost every area. All such situations are rising because of worsening storms, malting of glaciers, coastal erosions and ecological changes happening around the world[15,16].

3. Implementation

Drone technology has proven to be very helpful in life saving, less human interaction, wildlife monitoring etc. all such applications that had already been discussed. It has inspired researchers to use this technology with the fog computing architecture[17,18,19].

3.1. Smart Deforestation Detection System

In this paper, an IoT- fog based smart deforestation detection architecture is proposed and as shown in fig 1 where it consists of Smart Drones as IoT device, Actuators as Light Emitting Diode (LED) display, FoG Devices, A cloud data server. Smart drones consisting of capabilities of thermal imaging, clicking of high-resolution cameras are deployed over the forest area. These devices will be responsible for clicking of images of the wide forest areas and simultaneously those images will be feed to the fog nodes for processing. If any difference is found in the image record such as number of trees or any missing tree. That information from the fog node will be updated on the LED to the nearby forest department station. Data storage on the fog node is done for little amount of time, which is further moved to cloud for storage. Whenever any difference is found in the images captured by the drones that will be immediately notified to the mangers so that a timely action can be taken. Information on LED will be updated in every interval of five seconds. The fog-based deforestation system is stated in fig 1.

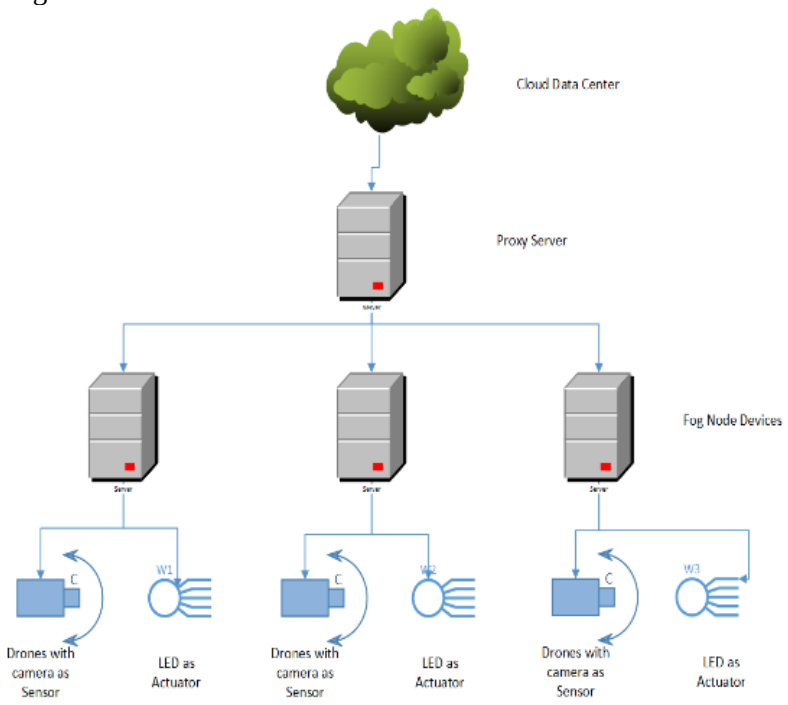

Figure 1: Smart Deforestation Detection System Architecture

3.2. Implementation of Scenario

To implement this scenario, construction of two modules is done in the simulator iFoGSim. Two modules are:

picture-capture: this module is embedded into the cameras installed in drones who are hovering and moving across the fields and capturing the images. In this simulating environment there are two things one as sensor which are used to take the information input to the processing system and actuator which takes the results obtained as an output after processing. All these with fog devices are created using the classes in the simulator. This module is programmed to capture the images after a interval of every 5 seconds.

tree-detector: All the pictures captured are given to the second module termed as tree-detector. This module is responsible for detection of any missing tree in the field.

SmartDeforestationDetection: researchers have created this class for simulating the complete scenario in the package known as “org.fog.test.perfeval”. This is the class which contains few existing implemented scenarios as well which contains DCNSFog, Two Apps, VRGameFog scenario implementation.

3.3. Parameter Evaluation

After the simulation of our scenario, we have analyzed the parameters such as:

3.3.1. Energy Consumption

In our scenario, we have used drones as sensors and LED as actuators and fog devices in an area and proxy server and cloud. Fig 2 and Fig 3 provide an illustrate to the calculation of energy consumption parameter done in the simulator. For energy calculation, two packages i.e. FogLinearPowerModel, cloudsim.power.PowerHost packages are derived.

3.3.2. Total Network Usage

Due to servers, fog devices, IoT devices the amount of data sent across the network is evaluated in the simulator. For this, package cloudsim.sdn.overbooking.BwProvisionerOverbooking is derived.

3.3.3. Execution Time

In iFoGSim, to calculate time package i.e. fog.utils.TimeKeeper is derived. Also, data updating will be continuously done by the drone camera with an interval of 5 seconds. Further, it calculates the total time taken to perform the execution of complete process.

3.3.4. Cost of Execution in Cloud

In ifogsim, input of cost in double type is taken in four forms. One is cost of using processing in this resource, second is cost of using memory in this resource and third is cost of using storage in this resource and last is cost of using bandwidth in the resource. All these types of cost are added as a parameter to the fog device characteristics.

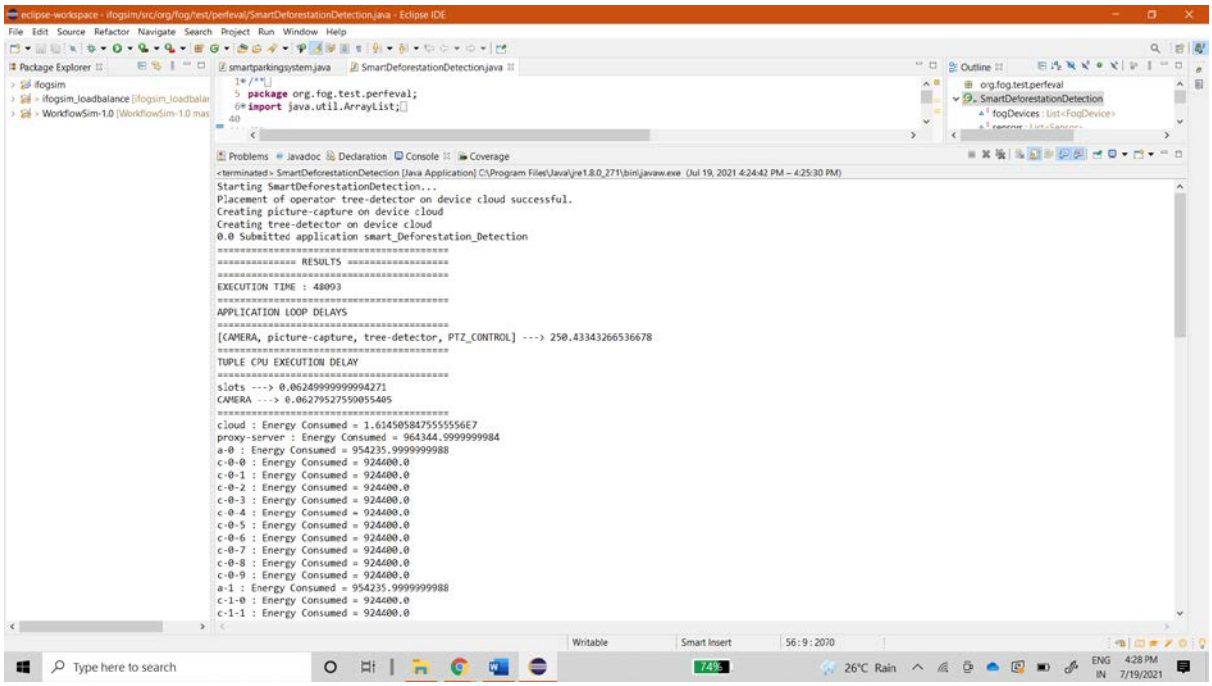

Figure 2: Simulation Results

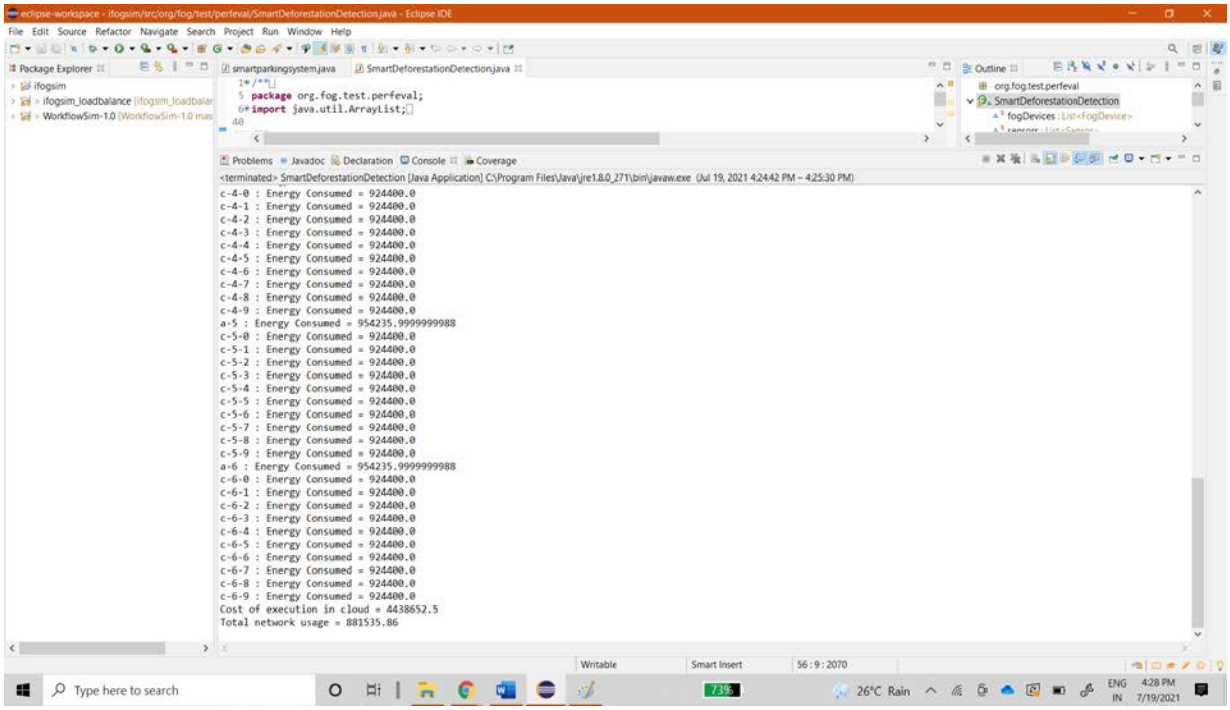

Figure 3: Simulation Results

4. Conclusion

Deforestation has come up to be a major problem for the forest ministry. This issue has arisen many other problems as change in climate, a lack of sustainability which has attracted researchers to work in this field. In this paper, a smart deforestation detection mechanism based on internet of things IoT-fog computing has been proposed. Discussion of complete setup of iFoGSim simulator is done with complete installation setup. Code snippets are also shared so that further research work can be accomplished. Studies have shown that with the usage of edge computing promising results are obtained. Still, there is a scope to embed artificial intelligence approach which can be used with edge computing to get more efficient results.

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