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Geo-tagging of plantation through limited internet connectivity

Chethan A S[1], Muneshwara M S[2]

[1]*Department of Mathematics, BMS Institute of Technology and Management, Bangalore 560064, aschethan@bmsit.in*
[2]*Department of Mathematics, BMS Institute of Technology and Management, Bangalore 560064, muneshwarams@ bmsit.in*

Abstract: In this paper we mainly focus on one application of Geo-Tagging where we need to identify a mobile application whose power of GPS and mobile network connectivity of a smartphone can be harnessed and used to geo-tag huge plantations whose land area span across many square kilometres, and which can help owners or workers of the plantation to know which and what type of plant species are grown at what part of the plantation.

Keywords: Geo tagging, Plantation, IOT

1. INTRODUCTION:

Smartphones, since their birth, have changed the lives of people who use them. Especially now, people have found new ways of using smartphones one could never even imagine. One such application is Geo-Tagging. This is a process of adding new information to a geographical location in the form of geospatial metadata which may contain and is not limited to name of the place, latitude-longitude, altitude, photographs, video, audio, websites, QR-codes, RSS Feed, etc. This feature is used by most applications for geo-tagging places of visit by users across the world. Some examples: Instagram is an application which is used to share photos and geo-tag them wherever people visit. Google Maps has a feature called Google Local Guide where people who visit places of tourism or heritage, can post pictures and videos they shoot, so that other users can look up the place on Google Maps and obtain information.

Ines Amaral [1] introduced Geo-tagging as a feature present in Web 2.0. Geotagging is the process of adding geospatial metadata. The geo-tagging processes derived from global position systems (GPS), which are based on a latitude and longitude coordinates model. Thus, the positions assumed by geotagging-enabled information services stem from this pattern. Geotagging is a feature that is presented individually to users. The users can share locations and add geolocated data to content. Adding geographical identification metadata to an information resource attaches value to the content by making it more searchable. it is a process of identifying geographic locations that empowers development of geographical databases, geo-referenced Web information, and geo-referenced multimedia.

A framework is proposed by Riyad Dhuny et. al [2] to spread awareness the public in order to plant trees and share location of plantation on a map. Hardware features of smartphones, HTML5 specifications, leaf recognition model, social networking, rewarding models are the features that make the framework popular. This framework will behave as main model to enhance many educational tools and games to be developed on the platform. It supports basic operations for platforms indulging in plant protection and afforestation.

Suporn Pongnumkul et al [3] focused on the use of a smartphone and how various sensors in it can be used beneficially in the field of Agriculture. On an estimate, there are around more than five billion smartphones currently being used in the world. One of the factors that enhances the smartphones' capability to help users to perform different tasks is the number of built-in sensors (e.g., motion sensors, cameras, positioning sensors, and microphones). Smartphones built with different sensors are opening new applications for rural farmers who once had low access to the latest agricultural resources like market, weather, etc. MapIT is a crowd-sourced camera based app for obtaining geo-spatial information of smaller objects and small agricultural areas.

In developing a database structure, relationships were established correctly between spatial feature classes and non-spatial feature classes of the rubber tree demonstration farm by Eduardson et al [4]. The actual results paved for the establishment and assignment of unique rubber tree identification number determined the exact quantity of trees ready for tapping and identified available land area considered potential for the expansion of the demonstration farm.

Mapping of fruit crop plantations using Indian Remote Sensing Satellite (IRS) data in Gujarat State was carried out jointly by the Directorate of Agriculture, with Bhaskaracharya Institute for Space Applications and Geo Informatics (BISAG). The major objective of this project was mapping of fruit crop plantations at village-level and preparation of village-level Horticultural Atlas of Gujarat State. High spatial resolution digital data from IRS LISS-IV covering major fruit growing districts in Gujarat state was analysed for identification. Maps of each village were geo-referenced with satellite data. Fruit crop plantations were located during field visits and their GPS locations were transferred to the satellite images for unique identification and accurate mapping. The fruit crops in different districts of Gujarat State were identified on the high accuracy and precise satellite information based on the planting pattern along with tree-crown density.

Qian Gyi Yu et al [5] introduced a smartphone-based app, known as eFarm: a crowdsourcing and human sensing application to accumulate geotagged Agricultural land information at the land parcel level, on the high resolution remotely-sensed images. Advantages of using the access of cameras, microphones and recording programs, geographical info, and GPS, allow a number of practical applications to be created, both in farming and its management.

Stutee Gupta et al [6] geo-tagged about 70 tree species which were commonly grown on their campus, with data such as provided a description of trees in terms of their distribution, classification, flower, fruiting, and economic importance along with a picture for easy identification. This was made by a in house made web application using Web-GIS. There after investigations were made by many authors in different directions.

In this paper we mainly focus on one application of Geo-Tagging where we need to identify a mobile application whose power of GPS and mobile network connectivity of a smartphone can be harnessed and used to geo-tag huge plantations whose land area span across many square kilometers, and which can help owners or workers of the plantation to know which and what type of plant species are grown at what part of the plantation. While many places including forest land and agriculture have a good amount of network and internet connectivity, in some parts of the world in countries like India, and Africa, a stable, reliable, and fast network and internet connectivity is still a long shot.

2. TECHNOLOGY USED:

Global Positioning System

The Global Positioning System (GPS), originally called as Navstar GPS, is a satellite-based radionavigation system owned by the US government and operated by the United States Space Force. This is one of the Global Navigation Satellite Systems (GNSS) that provides geolocation and timestamp information to a GPS receiver anywhere on or near the Earth where there is an clear line of sight to any of the four or more GPS satellites. Obstacles such as mountains, forests and buildings block the relatively weakened GPS signals.

There are 24 main GPS satellites that orbit Earth every 12 hours, sending a synchronized signal from each individual satellite. Because the satellites are moving in different directions, a user on the ground receives the signals at slightly different times. When at least four satellites get in touch with the receiver, it can calculate where the said user is – often to a precision of just a few feet, for civilian use.

The GPS need not require the user to transmit any data, and it operates exclusively of any cellular or internet reception, though these technologies improve the capabilities of the GPS location information. GPS provides many critical positioning abilities to civil, commercial, and military, users all over the world. The US government developed GPS, performs maintenance, and is readily available to any user with a GPS receiver.

The three segments of GPS are:

- **Space (Satellites) —** The satellites circling the Earth, transmitting signals to users on geographical position and time of day.
- **Ground Control —** The **Control Segment** is made up of Earth-based monitor stations, master control stations and ground antenna. Control activities include tracking and operating the satellites in space and monitoring transmissions. There are monitoring stations on almost every continent in the world, including North and South America, Africa, Europe, Asia and Australia.
- **User equipment —** GPS receivers and transmitters including items like watches, smartphones and telematic devices.

A single satellite broadcasts a microwave signal which is picked up by a GPS device and used to calculate the distance from the GPS device to the satellite.

There are likely thousands of applications for GPS systems, ranging from everything to helping hikers navigate in remote areas, to assisting farmers with precisely seeding their fields, to assisting drones with finding their targets.

The design and implementation of precision agriculture has made possible by GIS and GPS. These technologies allow combining real-time data with precise position information, leading to the efficient extrapolation and analysis of huge amounts of geo-spatial information. GPS-based use cases in implementing precision farming are used for farm planning, field mapping, soil sampling, tractor guidance, crop scouting and yield mapping. GPS also enables farmers to do work during reduced visibility field conditions such as storms, rains, and dust.

Cellular Network

A Cellular network or Mobile network is a microwave radio network distributed over land regions known as cells, each of them served by at least one location-fixed transceiver, referred to as a cell site or base station. In a cellular network, each cell uses varying set of frequencies from neighbouring cells, to avoid interference and provide true bandwidth within each cell.

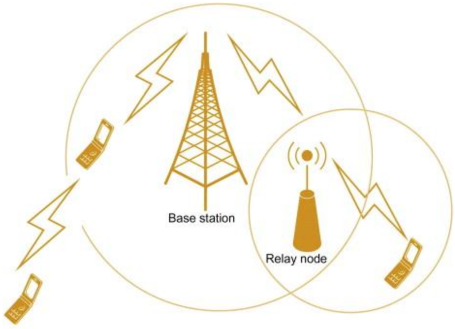

Fig. 1: Cellular Network

Cellular networks are high-speed, high-capability voice and data communication networks with multimedia and seamless roaming capabilities for supporting cellular devices. With the major rise in popularity of cellular devices, these networks are used for more than just entertainment and phone calls. They have become the main means of communication for business transactions, emergencies, mission-critical services like 911.

Advantages of Cellular Network:

- It is flexible enough to use the features and functions of almost all public and private networks.
- It has increased channel capacity.
- It consumes less power.
- It can be distributed to cover larger areas.
- It reduces interference from other signals.

Applications of Cellular Networks:

- Operator – Consumer applications: Mobile, smart TV's, video conferencing, Voice over IP.
- Machine – Machine applications: Data telemetry and automotive applications like connected cars, buses, etc.
- Mobile web services: Video and music streaming, finance, and social networking applications.

Firebase Database and Storage

The Firebase Realtime Database is a cloud-hosted database. Data is stored as JSON and in real-time to every connected client. When you build cross-platform apps with our Android, iOS and JavaScript SDKs, all of your clients share one Realtime Database instance and automatically receive updates with the newest data. Cloud Storage for Firebase is a powerful, simple, and cost-effective object storage service built for Google scale. The Firebase SDKs for Cloud Storage add Google security to file uploads and downloads for your Firebase apps, regardless of network quality.

3. PROBLEM DEFINITION

Using the application of Geo-tagging, we need to identify a mobile application whose power of GPS and mobile network connectivity of a smartphone can be harnessed and used to Geo-tag huge plantations whose land area span across many square kilometers, and which can help owners or workers of the plantation, with very limited network reliability and internet connectivity.

4. WORKING PRINCIPLE

A Photograph captured on an Android Mobile device consists of the following information:

- The photograph.
- The smartphone make (brand), model, year of manufacture.
- The specifications of the camera at the time of capture – aperture, ISO, focal length.
- Exchangeable Image File format (EXIF) data which contains – date and time of capture, geo-spatial data such as latitudinal and longitudinal coordinates, and approximate location name of the place where the picture was taken.

We are interested in the EXIF data to be able to geo-tag trees and plants, where we should be able to add the following data:

- Date and time of capture,
- Geo-spatial data such as latitudinal and longitudinal coordinates,
- Type and name of tree/plant species,
- Number of trees in the captured photograph.

Below is an example of the data generated when a picture is taken on an Android device.

Fig. 2: The Image

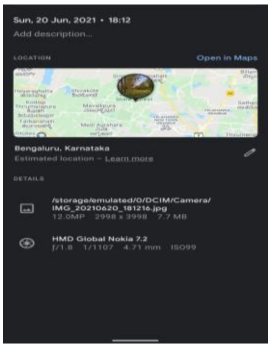

Fig. 3: The EXIF data of Image

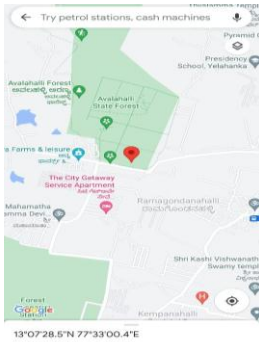

Fig. 4: The approximate location of the geo-tagged image

An Android application named Guru Nanak 550, has been identified as an app which uses the camera, GPS sensors, and the internet to help users geo-tag plantations and manage them. Published in 2018, this application has been downloaded more than 1 Trillion times from the Google Play Store.

This app was designed as a part of celebrating the 550th Birth anniversary of Guru Nanak, and to encourage people plant trees and medicinal plants, and geo-tag them using the app.

Fig. 5: About the App

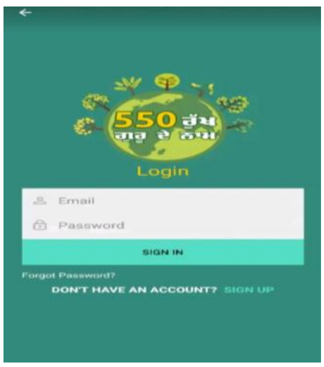

Fig. 6: Login Screen

Fig. 7: Main Menu

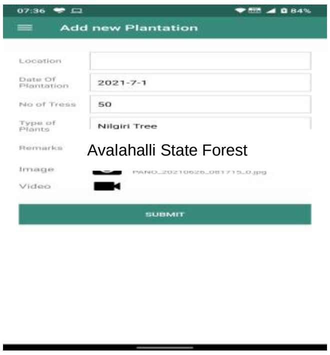

Fig. 8: Add New Plantation

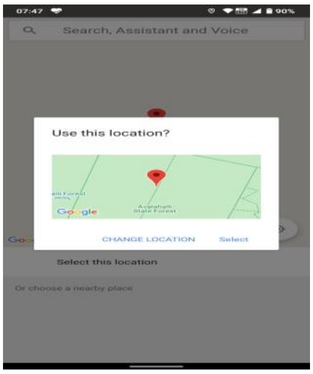

Fig 9: Adding location coordinates to photo

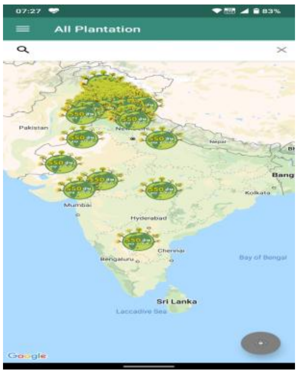

Fig. 10: All Plantations

Fig. 11: View Plantation

Workflow of the application:

- User has to register themselves on this application with name, email address and phone number.
- User should then login to the app, with registered email and password.
- User has to navigate to the main menu, choose “New Plantation”, and enter the details such as Location, Date of Plantation, Number of trees, Type of tree, Remarks.
- Under the location section, user will be prompted to turn on GPS, if not enabled. The current location will be determined. User may wish to submit the current location, or choose his/her own location and save the same.
- The user can either capture or browse already saved multiple photos or videos, and upload to the application.

- Once submitted, the user can view their plantations from the main menu by either choosing “My Plantations” or “My Plantation Map”.
- User can also view all the plantations, created by other users of the application worldwide.

The application itself is hosted on Google Cloud, and uses Google’s Firebase Database to store user and geo-spatial information, and Google’s Firebase Storage to store media assets such as photos and videos.

How Images and Videos are uploaded to Firebase storage in low internet connectivity:

- This application uses a python library called image slicer, which is used to split a given image into several small images, or a given video into several small video files.
- By this way, the application will work in the background to send these small images through the 2G network seamlessly.

```


import image_slicer

#image_slicer takes in the Photo taken by the user,
#and splits it into given number of smaller images.
image_slicer.slice('Photo.jpg', 10)



```

Fig. 12: Image Slicer logic

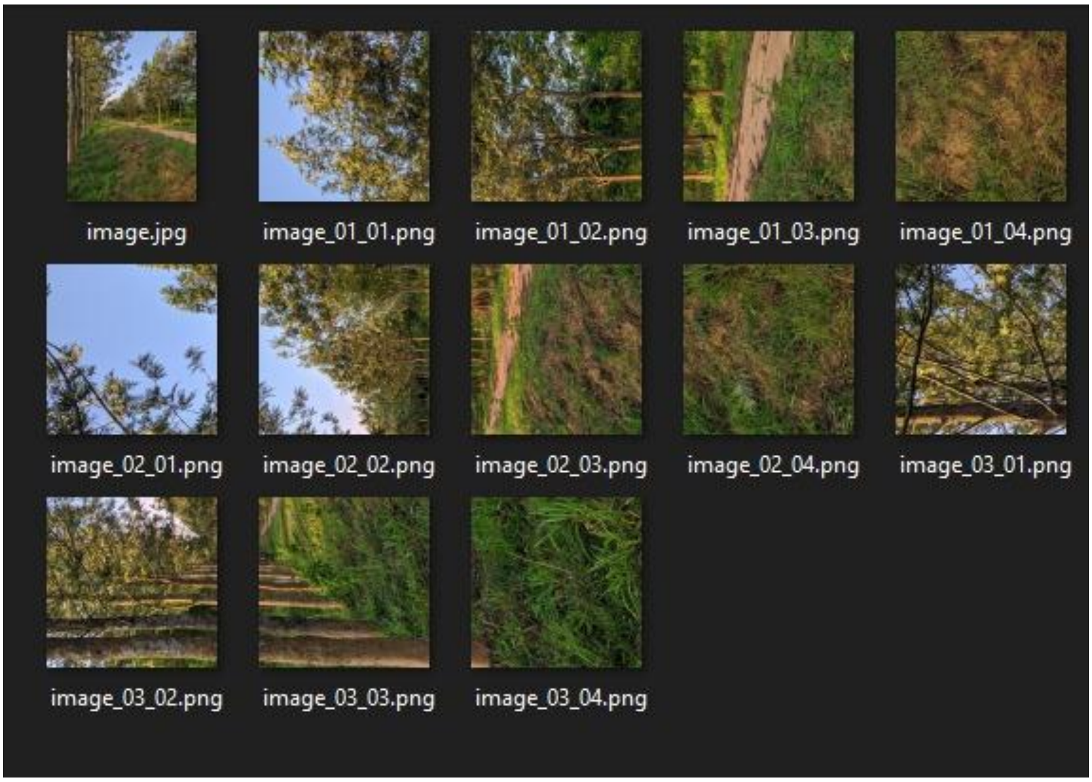

Fig. 13: Original Image and Split images

5. APPLICATIONS

1. Geo-Tagging Plantations: Geo-Tagging can be used to map, estimate, and analyze different species of flora across a huge area.
2. Logistics: Geo-tagging can be used in large warehouses and go-downs to keep track of items or raw materials, which will enhance organization and maintenance.
3. Museums: Nowadays, museums have audiobook devices, which act as audio guides for visitors. A tourist when he/she uses the device and moves around the museum, the audiobook, using geo-tagged information of places and artifacts, will automatically play the relevant information to the tourist.
4. Infrastructure: Geo-tagging of assets will ensure better monitoring, recording, and terrain mapping for future development works.
5. Crime and Cyber Crime: Police and Crime departments geo-tag crime scenes to map and thereby use measures to increase and control vigilance at such places, and also can be used as a useful tool for criminological research.
6. Geo-Tagging visited places: Geo-Tagging plays such an important role in applications like Google Maps, where anyone who visits a place can upload a picture or a video of the place with some useful information, so that it is readily accessible around the world.

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