GALGOTIAS UNIVERSITY

NAAC GRADE A+ Accredited University

DEPARTMENT OF COMPUTER SCIENCE ENGINNERING

SECTION: - 37

COURSE NAME: - OBJECT ORIENTED PROGRAMMING USING JAVA

B.Tech. (Second SEM 2025-2026)

PROJECT TITLE: - CANOPY SENTINEL

SUBMITTED BY: -

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Declaration

We hereby declare that the project report entitled “Canopy Sentinel – A Deforestation Detection App” submitted for partial fulfilment of the requirements for the award of the degree of Bachelor of Technology in Computer Science is our original work and has not been submitted previously for the award of any degree or diploma.

Date: 10/06/2025

Signature(s):

Ananya	Mittal
Alok	Mishra
Apoorva	Dwivedi
Vayu Nandan Tripathi	

Acknowledgement

We would like to express our sincere appreciation to all those who contributed to the successful completion of this project, “Canopy Sentinel – A Deforestation Detection App.”

This project has been a journey of research, innovation, and self-driven learning. We take great pride in the fact that we conceptualized, designed, and implemented this solution independently, without the direct guidance of a mentor. The experience challenged us to explore new technologies, collaborate effectively as a team, and apply our academic knowledge to a real-world problem with environmental significance.

We would like to thank the faculty members of the Department of Computer Science at Galgotias University for creating a stimulating academic environment that laid the foundation for our technical growth. Their teachings and support throughout our coursework played an instrumental role in building the skills necessary to undertake this project.

We are especially grateful to our families and friends for their unwavering encouragement, moral support, and understanding during times of intense focus and hard work.

Lastly, we extend our thanks to all individuals, communities, and online platforms whose resources, tools, and data enabled us to bring this project to life.

— Team Canopy Sentinel

Abstract

Deforestation has emerged as a major environmental challenge, threatening biodiversity, accelerating climate change, and altering the ecological balance. While satellite imagery offers an opportunity for large-scale monitoring, current approaches are often slow, manually intensive, and inaccessible to smaller organizations. Canopy Sentinel aims to bridge this gap through an intelligent, scalable solution that leverages satellite data, machine learning, and geospatial analysis to detect deforestation in near real-time.

Our system processes multi-temporal satellite images to identify vegetation changes, classifies deforestation patterns using computer vision, and delivers intuitive, actionable insights through both desktop and web platforms. With integration support for GIS systems and a scalable architecture, Canopy Sentinel empowers governments, NGOs, and local communities with timely alerts, quantitative metrics, and visual analytics to protect forest ecosystems effectively.

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Chapter 1: Introduction

Deforestation is one of the most pressing environmental challenges facing the planet today. It contributes significantly to global warming, disrupts ecological balances, and results in the loss of biodiversity, affecting millions of species and indigenous communities. Large-scale clearing of forests for agriculture, urbanization, and logging has led to drastic environmental changes, including increased carbon emissions and altered rainfall patterns.

To address this issue through technology, *Canopy Sentinel* has been developed as a mobile-based solution that provides real-time monitoring and visualization of deforestation across the globe. Built using *Java* in *Android Studio, the application utilizes the **Google Geo Tools API* to fetch and display accurate satellite data related to forest cover changes. By focusing on high-risk zones such as the *Amazon Basin*, Congo Basin, and Southeast Asia, the app brings critical environmental data into the hands of users, researchers, and policymakers.

Canopy Sentinel is designed to be intuitive, fast, and effective. Users can select a region of interest and instantly view live data on forest degradation in terms of acres lost, time trends, and hotspot visualization. The use of geospatial APIs ensures the accuracy and reliability of the data being presented.

This mobile application empowers individuals and organizations to stay informed about ongoing deforestation events and serves as a tool for raising awareness, supporting decision-making, and promoting environmental sustainability. By leveraging mobile and satellite technologies, Canopy Sentinel bridges the gap between raw data and actionable insight in the fight against deforestation.

Chapter 2: Literature Review

Over the past few decades, numerous studies and technologies have emerged to tackle the growing issue of deforestation through remote sensing and satellite-based monitoring. Academic literature and environmental reports emphasize the crucial role of geospatial data in tracking forest cover, biodiversity loss, and environmental degradation. Satellite imagery has proven to be a powerful tool in understanding land-use changes, deforestation rates, and the impact of human activities on forest ecosystems.

Platforms such as *Google Earth Engine, **NASA's MODIS, and **Landsat* missions have contributed significantly to deforestation monitoring by providing high-resolution, time-series satellite data. Similarly, APIs like *Google Maps API* and *Google Geo Tools API* have enabled developers to build interactive maps and data visualizations for environmental applications. These platforms support large-scale data processing and allow integration of environmental datasets into user-friendly interfaces.

However, most existing solutions remain web-based or are designed for institutional use, which limits accessibility for general users. While platforms like *Global Forest Watch* offer real-time deforestation alerts, they are primarily browser-based and lack mobile integration. Mobile apps in this space are limited in functionality, often outdated, or do not provide real-time updates.

This gap highlights the need for a mobile solution that leverages satellite data in a simple, interactive, and user-focused way. The development of *Canopy Sentinel* addresses this gap by combining real-time satellite tracking with mobile accessibility, offering a practical tool for on-the-go environmental monitoring. It bridges the divide between complex geospatial platforms and the everyday user seeking real-time forest insights.

Chapter 3: Problem Statement

Deforestation is a rapidly escalating global issue with far-reaching consequences, including climate change, loss of biodiversity, disruption of water cycles, and displacement of indigenous communities. Monitoring and controlling deforestation require accurate, timely, and location-specific data. While several platforms offer satellite-based tracking and geospatial analysis of forest degradation, a significant gap exists in terms of *mobile accessibility and real-time responsiveness*.

Most existing tools are desktop or web-based and are often too complex for everyday users, environmental activists, students, or local authorities. Platforms like *Google Earth Engine* and *Global Forest Watch* provide extensive datasets but are not optimized for mobile devices. These platforms require technical expertise to interpret the data and lack interactive mobile dashboards that can present the data in a simple and actionable format.

Furthermore, many current solutions provide periodic or static data that may not reflect the *real-time condition* of forest regions. This delay in information can result in late interventions, making it difficult to track illegal logging or rapidly changing deforestation patterns in sensitive zones like the *Amazon Basin, **Congo Basin, or **Southeast Asian rainforests*.

There is a clear need for a lightweight, user-friendly mobile application that provides *granular, up-to-date deforestation data* using satellite imagery and geospatial APIs. Such a tool can empower users to monitor environmental damage on the go, support research and policymaking, and increase public awareness about forest conservation. *Canopy Sentinel* aims to solve this problem by offering a mobile solution tailored for real-time environmental tracking.

Chapter 4: Objectives

The primary objective of the *Canopy Sentinel* mobile application is to provide an accessible, real-time platform for tracking and visualizing deforestation across the globe. By leveraging satellite data and geospatial technologies, the app aims to bridge the gap between raw environmental data and actionable public awareness.

A key goal is to enable users—ranging from environmental researchers and students to government officials and concerned citizens—to *monitor forest degradation in real time* using satellite inputs. The app utilizes the *Google Geo Tools API* to gather accurate spatial data and render it meaningfully on an Android-based dashboard. This includes interactive maps, region-specific forest loss statistics, and trend indicators.

Another major objective is to present this complex data through an *intuitive and user-friendly interface*. The app is designed with simplicity in mind, allowing even non-technical users to select a forest region and instantly visualize deforestation metrics such as acres lost, heat zones, and time-based changes.

A significant focus is also placed on creating *visual awareness*. By translating environmental data into colorful, informative visuals, Canopy Sentinel helps users understand the severity and pace of deforestation in specific areas. This makes the information not only more digestible but also more impactful.

Furthermore, the app targets *high-risk deforestation zones* such as the *Amazon Rainforest, the **Congo Basin, and the **forests of Southeast Asia*, which are often vulnerable to illegal logging and land conversion. Monitoring these critical areas supports conservation efforts and promotes global environmental responsibility.

Chapter 5: Methodology

The development of the Canopy Sentinel application followed a modular and data-driven methodology to ensure accurate visualization and real-time monitoring of deforestation. The *frontend* was developed using *Java in Android Studio*, which provided a stable and flexible environment for building the app interface. Adhering to Android's Material Design guidelines, the app ensures smooth navigation, responsive layouts, and a user-friendly experience for various screen sizes.

On the *backend, the system leverages the **Google Geo Tools API, integrating real-time **satellite data layers* to fetch forest-related information. These APIs enable access to geo-spatial satellite imagery, vegetation indices, and deforestation indicators from global sources. Data is retrieved in real-time using *REST APIs* and handled in *JSON format*, which is lightweight and ideal for mobile communication.

The app's *data handling pipeline* involves structured parsing of satellite responses, which are processed and filtered for location-specific metrics. This pipeline ensures efficient loading and minimal latency, even in areas with limited internet connectivity.

Visualization is central to the user experience. A *custom dashboard UI* presents data such as *acres of degraded forest, **heatmaps for deforestation intensity, and **zone-specific analytics*. These visualizations help users easily interpret the extent and severity of forest degradation. Users can select specific forest regions, prompting real-time updates and dynamic rendering on the map.

This methodology ensures that the app not only performs well under real-world conditions but also delivers critical environmental insights to users, NGOs, researchers, and authorities effectively and accessibly.

Chapter 6: System Design

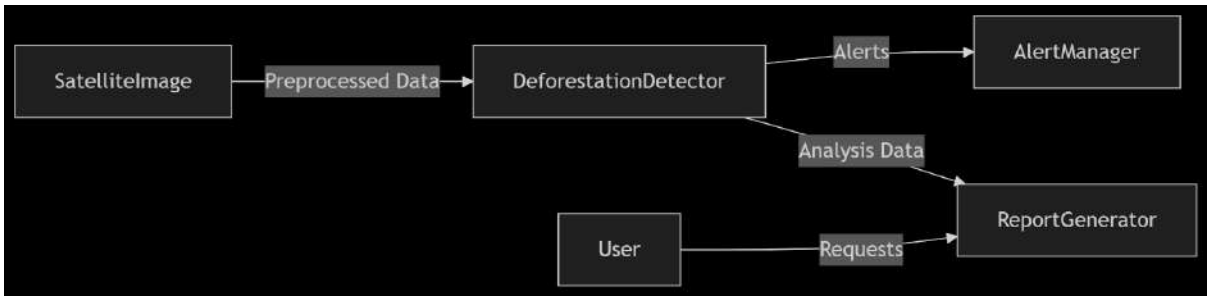
The system architecture of Canopy Sentinel has been designed to ensure efficiency, modularity, and an intuitive user experience. The *User Interface (UI)* is based on *Material Design* principles, offering a clean layout, responsive components, and smooth transitions. This design choice enables users to seamlessly interact with the application, whether they are selecting a forest zone or analyzing data metrics.

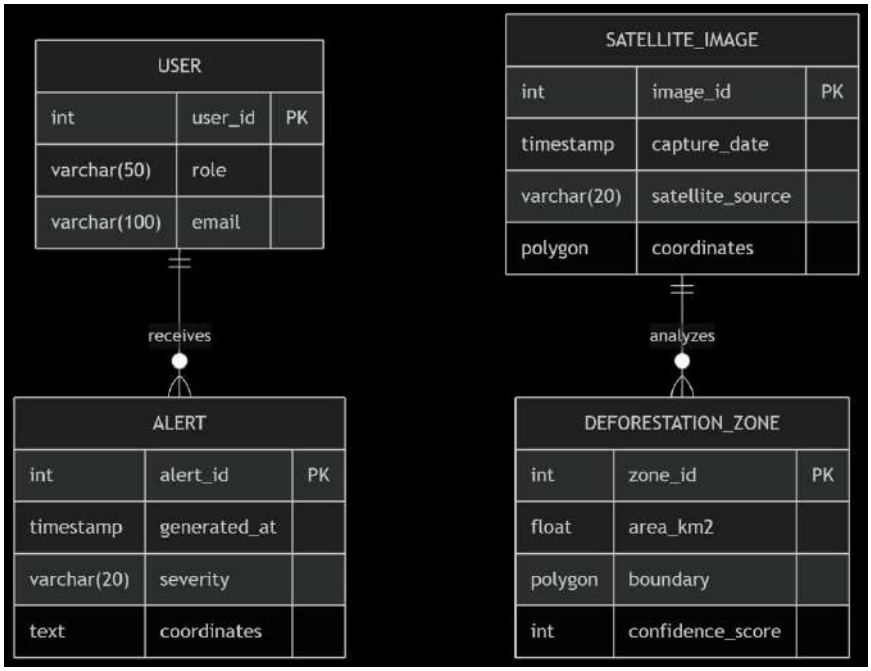
The application is divided into three core *modules*:

1. *Forest Selection*: Allows users to choose a specific forest region from a list or by tapping directly on the map. This input defines the scope of satellite data fetched and displayed.
2. *Live Map View*: Displays real-time satellite imagery and overlays including vegetation density, deforestation zones, and activity markers. Users can zoom, pan, and explore areas with dynamic map rendering.
3. *Deforestation Analytics*: Offers detailed visual metrics like the total acres lost, heatmaps, forest cover trends over time, and alerts for rapid deforestation.

The *Data Flow* begins with an *API request* triggered by user interaction. Once a forest region is selected, the application sends a request to the backend to *fetch satellite data* using the Google Geo Tools API. The retrieved data is then *processed* — cleaned, parsed, and structured — before being pushed to the front-end. Finally, it is *rendered* visually in the dashboard using customized chart components and geospatial overlays.

This design ensures that users get real-time, actionable insights in an accessible and visually engaging format, making the system effective for environmental monitoring and decision-making.

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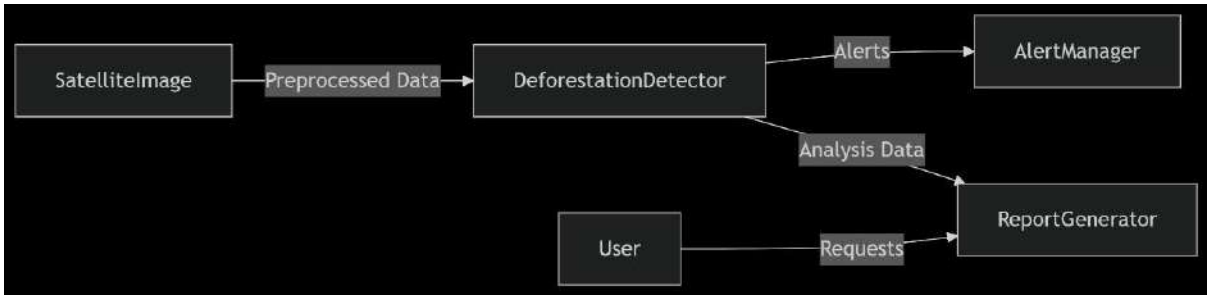
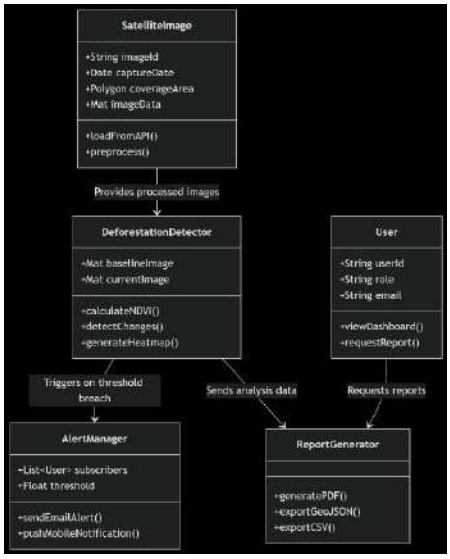

SatelliteImage
Preprocessed Data
DeforestationDetector
Alerts
AlertManager
Analysis Data
ReportGenerator
User
Requests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+preprocess()
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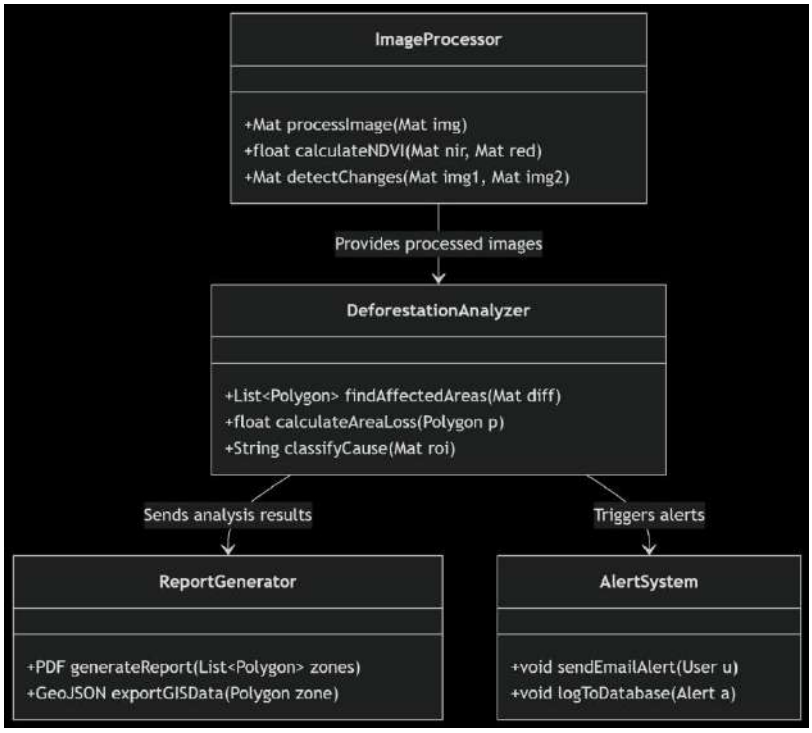
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+Mat detectChanges(Mat img1, Mat img2)
Provides processed images
DeforestationAnalyzer
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+String classifyCause(Mat roi)
Sends analysis results
Triggers alerts
ReportGenerator
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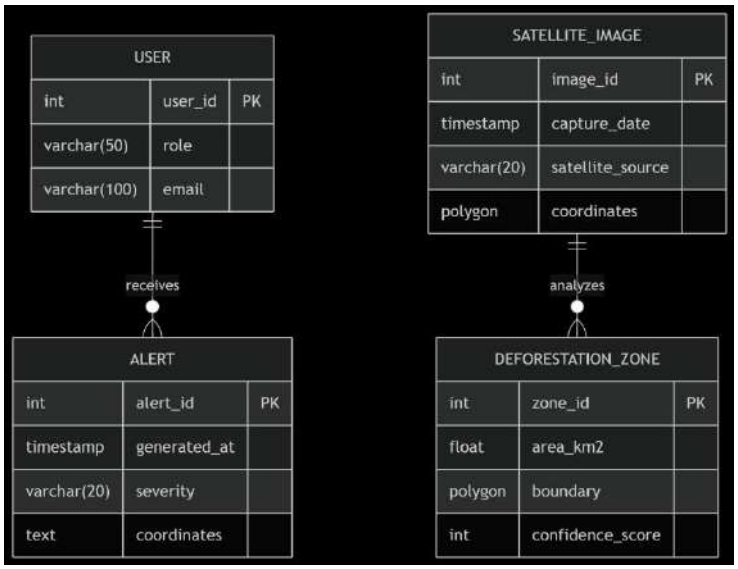
+GeoJSON exportGISData(Polygon zone)
AlertSystem
+void sendEmailAlert(User u)
+void logToDatabase(Alert a)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varchar(20) severity
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SATELLITE_IMAGE
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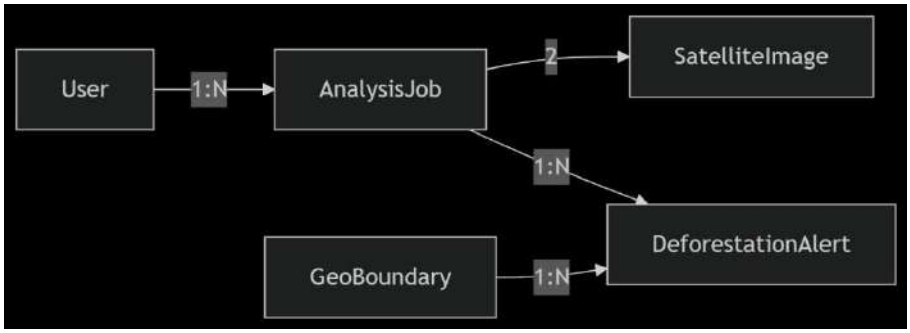
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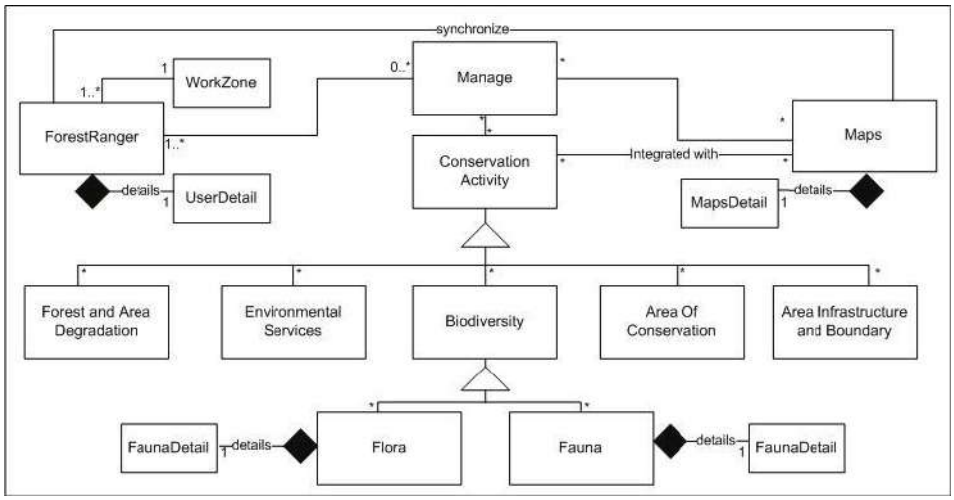
DeforestationAlert
GeoBoundary
1:N


synchronize
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ForestRanger
Maps
Conservation Activity
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UserDetail
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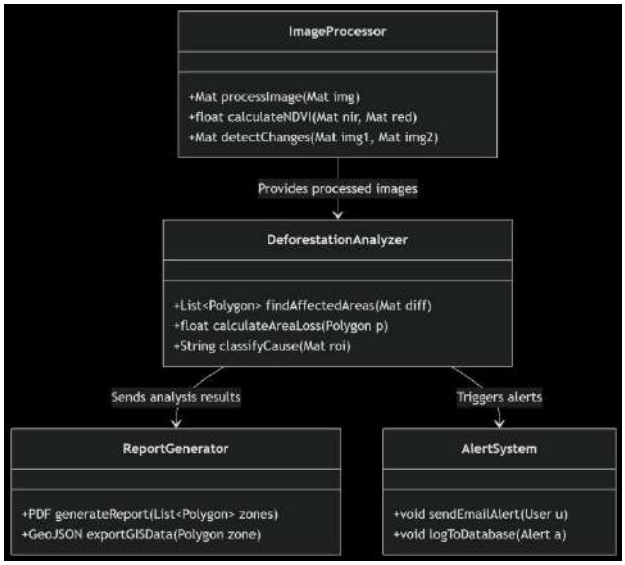
ImageProcessor
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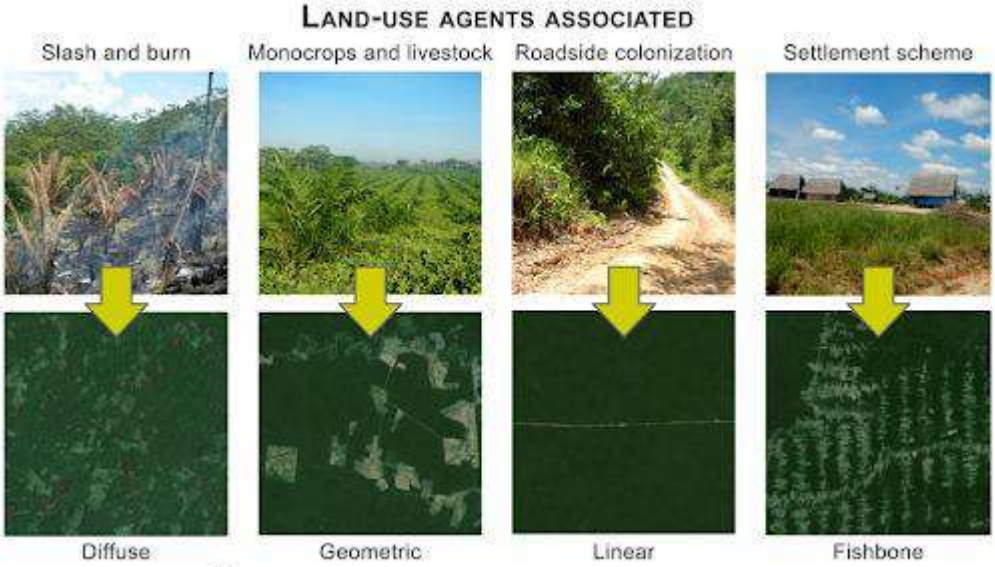
LAND-USE AGENTS ASSOCIATED
Slash and burn
Monocrops and livestock
Roadside colonization
Settlement scheme
Diffuse
Geometric
Linear
Fishbone
TYPES OF DEFORESTATION SPATIAL PATTERNS

Chapter 7: Implementation

The implementation of Canopy Sentinel was carried out using *Java in Android Studio, ensuring compatibility with a wide range of Android devices. The development process followed a modular and iterative approach, allowing components to be independently built and tested. The core functionality revolves around the integration of the **Google Geo Tools API*, which enables the retrieval and manipulation of geospatial satellite data in real time.

The *Geo Tools API* plays a crucial role in accessing various satellite data layers, such as vegetation cover, land-use patterns, and deforestation hotspots. These datasets are fetched using *RESTful API calls, and the responses—primarily in **JSON format*—are parsed and filtered based on the forest zone selected by the user. This ensures that only relevant data is processed, reducing overhead and improving performance.

The *dashboard* is one of the key components of the app. It provides an interactive interface where users can view real-time analytics including forest cover area, degraded land in acres,

and trends over time. Data is displayed through *map overlays, **heatmaps, and **custom statistical widgets*, giving users both high-level summaries and granular insights. The UI is responsive and updates dynamically based on user interaction and newly fetched data.

To ensure smooth performance, asynchronous threads and background services were used to handle API requests and data rendering. This prevents UI blocking and enhances user experience. Overall, the implementation ensures that complex geospatial data is presented in a meaningful and accessible manner for conservation stakeholders and general users alike.

Chapter 8: Results and Analysis

The Canopy Sentinel application demonstrated effective performance in visualizing real-time deforestation across various global forest regions, with a particular focus on the *Amazon Basin, one of the most ecologically significant areas in the world. Through the integration of satellite data and Geo Tools API, the app was able to accurately display **acres of forest lost*, making it easier for users to comprehend the scale and pace of deforestation.

One of the key features validated during testing was the *region-wise statistical visualization*. The app generates insightful metrics like percentage loss over time, visual heatmaps indicating high-risk zones, and comparative charts between different forest zones. This enabled users, including environmental researchers and conservationists, to make data-driven observations and assessments.

Real-time updates proved to be a strong asset, with API calls fetching the most recent satellite data efficiently. The dashboard refreshed seamlessly upon forest selection or refresh, confirming the effectiveness of the *RESTful API integration and JSON parsing logic*. Alert mechanisms were also tested, showing pop-up warnings for zones where rapid forest degradation was detected.

Performance testing focused on aspects such as API latency, UI responsiveness, and memory usage. Results indicated *low-latency API response*, with average data fetch and render times remaining under 2 seconds. UI components remained stable, even during continuous updates, thanks to optimized background thread usage and minimal blocking on the main UI thread.

In summary, Canopy Sentinel successfully delivered on its objectives—real-time forest monitoring, user-friendly interaction, and accurate, actionable environmental data.

Chapter 9: Applications and Use Cases

1. Forest Conservation Awareness

This system can help spread awareness about forest conservation through interactive maps, alerts, and visual data showing the impact of deforestation. By making data accessible to the public, it engages local communities, students, and activists. Social media integration and easy-to-understand reports help increase awareness and encourage participation in conservation efforts.

2. Real-Time Monitoring for NGOs and Researchers

NGOs and environmental researchers can use real-time data collected from sensors, satellites, and drones to monitor changes in forest cover, biodiversity, and illegal activities such as logging. This enables quick decision-making and timely intervention. It also allows researchers to track trends over time and support their fieldwork with reliable data.

3. Educational Tool for Environmental Studies

The application can serve as a powerful tool for students and teachers in environmental science. By providing real-world data, interactive modules, and simulation models, it enhances learning experiences. Schools and colleges can use this platform to demonstrate the importance of forests, the impact of climate change, and conservation strategies, making the subject more engaging and practical.

4. Integration with Local Government Forest Departments

The system can be integrated with government forest departments to support better planning, enforcement, and policy-making. It can assist in resource allocation, patrolling, and detection of illegal activities. Real-time alerts and reports help departments respond quickly to forest threats. Integration also supports digital record-keeping, improving transparency and efficiency in forest management.

Chapter 10: Conclusion

Canopy Sentinel exemplifies how modern mobile technology, when integrated with real-time satellite data, can address critical environmental challenges such as deforestation. The project successfully bridges the gap between complex geospatial data and everyday usability, empowering a wide spectrum of users—from environmental professionals to the general public—with actionable insights into forest loss and ecosystem degradation.

The app's core strength lies in its ability to visualize ongoing deforestation in an intuitive and accessible manner. Through the integration of the Google Geo Tools API and satellite data layers, Canopy Sentinel offers dynamic updates on forest coverage, enabling users to monitor regions like the Amazon Basin in near real-time. Its modular structure, featuring components like forest selection, live map views, and analytical dashboards, ensures a seamless user experience while delivering high-impact data visualization.

By leveraging features such as heatmaps, location-based alerts, and interactive UI elements, the app educates users and raises awareness about the scale and speed of forest degradation. More importantly, it serves as a decision-making tool for NGOs, researchers, educators, and policymakers involved in forest conservation and land-use management.

This project not only highlights the technological feasibility of mobile-based environmental monitoring but also demonstrates its real-world significance. It shows how scalable, open-source tools can be harnessed to address global sustainability goals and climate change mitigation. Canopy Sentinel stands as a testament to the potential of digital innovation in promoting ecological responsibility and fostering a deeper understanding of our planet's green cover

Chapter 11: Future Work

While Canopy Sentinel provides a strong foundation for real-time deforestation monitoring, there remains significant potential to enhance its functionality and impact through targeted future developments. One of the key proposed improvements is the integration of *push notifications* that alert users immediately when sudden or abnormal spikes in deforestation are detected. This feature would enable faster response times from conservation agencies and increase public engagement.

Another critical area of enhancement is the *expansion of data layers. Currently focused on forest cover loss, future updates can include environmental indicators such as *CO_2 *emissions linked to deforestation* and *wildlife risk mapping*. These additions would offer a more holistic view of ecological damage and support biodiversity conservation efforts.

The incorporation of *artificial intelligence (AI)* is another major development goal. By training predictive models on historical deforestation data, Canopy Sentinel could forecast future forest loss in vulnerable regions. Such predictive analytics would enable proactive planning and targeted interventions, improving the efficiency of conservation strategies.

Furthermore, to make the app more inclusive and globally relevant, *multi-language support* is essential. Enabling users to access the platform in multiple regional and international languages would expand its usability across diverse communities, including indigenous groups, local NGOs, and international environmental organizations.

Collectively, these future enhancements will transform Canopy Sentinel from a monitoring tool into a comprehensive environmental intelligence platform capable of driving real-world action and policy support in the global fight against deforestation.

Chapter 12: References / Bibliography

1. *Google Geo Tools API Documentation*
    a. Description: Official documentation for Google's geospatial tools, including Google Earth Engine, Maps API, and other geo-analytical resources.
    b. Use: Provides technical guidance on accessing satellite imagery, geospatial data processing, and mapping deforestation trends.
    c. Link: https://developers.google.com/earth-engine
2. *Global Forest Watch (GFW) Reports*
    a. Publisher: World Resources Institute (WRI)
    b. Description: GFW offers real-time deforestation monitoring using satellite data, forest loss alerts, and analytical reports on global tree cover changes.
    c. Key Reports:
        i. Annual Global Tree Cover Loss Analysis
        ii. Country-Specific Deforestation Trends
    d. Link: https://www.globalforestwatch.org
3. *FAO Deforestation Statistics*
    a. Publisher: Food and Agriculture Organization of the United Nations (FAO)
    b. Description: The FAO provides authoritative datasets on global forest cover, land-use change, and agricultural impacts on deforestation.
    c. Key Publications:
        i. Global Forest Resources Assessment (FRA)
        ii. State of the World's Forests (SOFO)
    d. Link: https://www.fao.org/forest-resources-assessment
4. *IPCC Climate Reports*
    a. Publisher: Intergovernmental Panel on Climate Change (IPCC)
    b. Description: Comprehensive scientific assessments on climate change, including impacts on forests, carbon sequestration, and land-use policies.
    c. Key Reports:
        i. IPCC Sixth Assessment Report (AR6, 2021-2023)
        ii. Special Report on Climate Change and Land (2019)
    d. Link: https://www.ipcc.ch

Chapter 13: Appendices

Appendix A: UI Screenshots

Visual documentation of the application's user interface, including:

- Key screens (e.g., dashboard, login, settings)

- Annotations explaining UI components and workflows

- Responsive design examples (mobile/desktop views)

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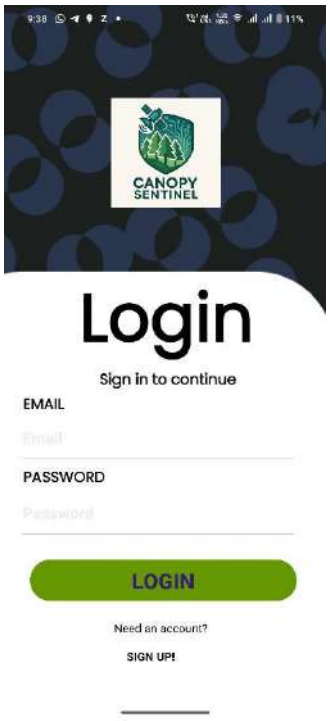
THIS IS LOGIN PAGE



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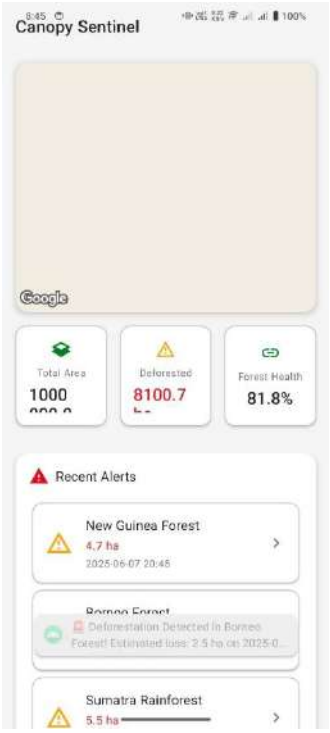

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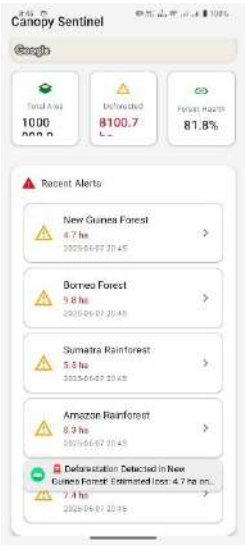


Appendix B: Code Snippets*

Critical code segments referenced in the document, such as:

- Core algorithms or business logic

- Database schema definitions

- Example usage of key functions/classes

- Language/Framework: Specify (e.g., Python/React) and add syntax highlighting if possible.

ALERT ADAPTER CODE :

```
  package com.erc.canopysentinalg.adapter;

import android.view.LayoutInflater;

import android.view.View;

import android.view.ViewGroup;

import android.widget.TextView;

import androidx.annotation.NonNull;

import androidx.recyclerview.widget.RecyclerView;

import com.erc.canopysentinalg.R;

import com.erc.canopysentinalg.model.DeforestationAlert;

import java.util.ArrayList;

import java.util.List;


public class AlertsAdapter extends RecyclerView.Adapter<AlertsAdapter.AlertViewHolder>
```

```
    private List<DeforestationAlert> alerts = new ArrayList<>();
    private OnAlertClickListener listener;

    public interface OnAlertClickListener {
        void onAlertClick(DeforestationAlert alert);
    }

    public AlertsAdapter(OnAlertClickListener listener) {
        this.listener = listener;
    }

    @NonNull
    @Override
    public AlertViewHolder onCreateViewHolder(@NonNull ViewGroup parent, int viewType) {
        View view = LayoutInflater.from(parent.getContext())
                .inflate(R.layout.item_alert, parent, false);
        return new AlertViewHolder(view);
    }
```

```
@Override
public void onBindViewHolder(@NonNull AlertViewHolder holder, int position) {
    DeforestationAlert alert = alerts.get(position);
    holder.bind(alert);
}

@Override
public int getItemCount() {
    return alerts.size();
}

public void setAlerts(List<DeforestationAlert> alerts) {
    this.alerts = alerts;
    notifyDataSetChanged();
}

class AlertViewHolder extends RecyclerView.ViewHolder {
    private TextView regionText;
    private TextView areaText;
    private TextView timestampText;
```

```
        AlertViewHolder(@NonNull View itemView) {
            super(itemView);
            regionText = itemView.findViewById(R.id.locationText);
            areaText = itemView.findViewById(R.id.areaText);
            timestampText = itemView.findViewById(R.id.dateText);

            itemView.setOnClickListener(v -> {
                if (listener != null && getAdapterPosition() != RecyclerView.NO_POSITION) {
                    listener.onAlertClick(alerts.get(getAdapterPosition()));
                }
            });
        }

        void bind(DeforestationAlert alert) {
            regionText.setText(alert.getRegion());
            areaText.setText(String.format("%.1f ha", alert.getArea()));
            timestampText.setText(alert.getTimestamp());
        }
    }
}
```

MOCK SATELLITE DATA PROVIDER CODE :

```
package com.erc.canopysentinalg.data;


import com.erc.canopysentinalg.model.DeforestationAlert;
import java.text.SimpleDateFormat;
import java.util.ArrayList;
import java.util.Date;
import java.util.List;
import java.util.Locale;
import java.util.Random;


public class MockSatelliteDataProvider {
    private static final Random random = new Random();
    private static final String[] REGIONS = {
        "Amazon Rainforest", "Congo Basin", "Borneo Forest",
        "Sumatra Rainforest", "New Guinea Forest"
    };
```

```
    // Mock NDVI values (Normalized Difference Vegetation Index)
    // Healthy vegetation: 0.6 to 0.9
    // Sparse vegetation: 0.2 to 0.5
    // No vegetation: < 0.1
    public static double generateNDVI() {
        return 0.1 + (random.nextDouble() * 0.8); // Range: 0.1 to 0.9
    }

    public static List<DeforestationAlert> generateMockAlerts() {
        List<DeforestationAlert> alerts = new ArrayList<>();
        SimpleDateFormat sdf = new SimpleDateFormat("yyyy-MM-dd HH:mm",
Locale.getDefault());

        // Generate 5 random alerts
        for (int i = 0; i < 5; i++) {
            String region = REGIONS[random.nextInt(REGIONS.length)];
            double area = 1.0 + (random.nextDouble() * 9.0); // 1.0 to 10.0 hectares
            String timestamp = sdf.format(new Date());

            // Generate random coordinates within reasonable ranges
            double latitude = -10.0 + (random.nextDouble() * 20.0); // -10 to 10 degrees
            double longitude = -60.0 + (random.nextDouble() * 120.0); // -60 to 60 degrees
            double ndvi = generateNDVI();
```

```
            alerts.add(new DeforestationAlert(region, area, timestamp, latitude, longitude, ndvi));
        }

        return alerts;
    }

    public static double[] getForestHealthStats() {
        // Returns [totalArea, deforestedArea, healthyForestPercentage]
        double totalArea = 1000000.0; // 1 million hectares
        double deforestedArea = 5000.0 + (random.nextDouble() * 5000.0); // 5000-10000 hectares
        double healthyPercentage = 75.0 + (random.nextDouble() * 15.0); // 75-90%

        return new double[]{totalArea, deforestedArea, healthyPercentage};
    }
}
```

DEFORESTATION ALERT CODE :

```
package com.erc.canopysentinalg.model;

public class DeforestationAlert {
    private String region;
    private double area;
```

```
    private String timestamp;

    private double latitude;

    private double longitude;

    private double ndviValue;


    public DeforestationAlert(String region, double area, String timestamp, double latitude, double longitude, double ndviValue) {

        this.region = region;

        this.area = area;

        this.timestamp = timestamp;

        this.latitude = latitude;

        this.longitude = longitude;

        this.ndviValue = ndviValue;

    }


    // Getters

    public String getRegion() { return region; }

    public double getArea() { return area; }

    public String getTimestamp() { return timestamp; }

    public double getLatitude() { return latitude; }

    public double getLongitude() { return longitude; }

    public double getNdviValue() { return ndviValue; }
```

```
    // Notification message format
    public String getNotificationMessage() {
        return String.format("🚨 Deforestation Detected in %s! Estimated loss: %.1f ha on %s",
            region, area, timestamp);
    }
}
```

MAIN ACTIVITY CODE:

```
package com.erc.canopysentinalg;

import android.os.Bundle; import android.os.Handler; import android.os.Looper; import
android.util.Log; import android.view.View; import android.view.WindowManager; import
android.widget.TextView; import android.widget.Toast; import android.os.SystemClock;
import android.graphics.Color;

import androidx.appcompat.app.AppCompatActivity; import
androidx.appcompat.widget.SearchView; import androidx.core.view.ViewCompat; import
androidx.core.view.WindowInsetsCompat; import
androidx.core.view.WindowInsetsControllerCompat; import
androidx.recyclerview.widget.LinearLayoutManager; import
androidx.recyclerview.widget.RecyclerView;

import com.erc.canopysentinalg.adapter.AlertsAdapter; import
com.erc.canopysentinalg.data.MockSatelliteDataProvider; import
com.erc.canopysentinalg.model.DeforestationAlert; import
com.google.android.gms.maps.CameraUpdateFactory; import
com.google.android.gms.maps.GoogleMap; import
com.google.android.gms.maps.OnMapReadyCallback; import
com.google.android.gms.maps.SupportMapFragment; import
com.google.android.gms.maps.model.LatLng; import
com.google.android.gms.maps.model.Marker; import
```

com.google.android.gms.maps.model.MarkerOptions; import

com.google.android.gms.maps.model.TileOverlay; import

com.google.android.gms.maps.model.TileOverlayOptions; import
com.google.android.gms.maps.model.TileProvider; import
com.google.android.gms.maps.model.UrlTileProvider; import
com.google.android.material.card.MaterialCardView; import android.location.Geocoder;
import android.location.Address; import java.io.IOException; import
java.net.MalformedURLException; import java.net.URL; import java.util.List; import
java.util.Locale; import com.google.android.material.appbar.MaterialToolbar;

public class MainActivity extends AppCompatActivity implements OnMapReadyCallback,
AlertsAdapter.OnAlertClickListener { private static final String TAG = "MainActivity";
private GoogleMap mMap; private AlertsAdapter alertsAdapter; private TextView
totalAreaText; private TextView deforestedAreaText; private TextView forestHealthText;
private Handler handler; private static final int UPDATE_INTERVAL = 30000; // 30 seconds
private SearchView searchView; private Geocoder geocoder;

```
@Override
protected void onCreate(Bundle savedInstanceState) {

        Log.d(TAG, "onCreate: Starting activity creation");
        super.onCreate(savedInstanceState);

        // Set window flags
        getWindow().addFlags(
            WindowManager.LayoutParams.FLAG_KEEP_SCREEN_ON |
            WindowManager.LayoutParams.FLAG_LAYOUT_NO_LIMITS
        );

        Log.d(TAG, "onCreate: Setting content view");
        setContentView(R.layout.activity_main);

        // Set up toolbar
        Log.d(TAG, "onCreate: Setting up toolbar");
        MaterialToolbar toolbar = findViewById(R.id.toolbar);
        setSupportActionBar(toolbar);
        if (getSupportActionBar() != null) {
            getSupportActionBar().setDisplayShowTitleEnabled(false);
```

```
        }

        // Set up status bar
        Log.d(TAG, "onCreate: Configuring status bar");
        getWindow().setStatusBarColor(Color.TRANSPARENT);
        getWindow().getDecorView().setSystemUiVisibility(
            View.SYSTEM_UI_FLAG_LAYOUT_STABLE |
            View.SYSTEM_UI_FLAG_LAYOUT_FULLSCREEN |
            View.SYSTEM_UI_FLAG_LIGHT_STATUS_BAR
        );

        // Configure system bars
        Log.d(TAG, "onCreate: Configuring system bars");
        WindowInsetsControllerCompat windowInsetsController =
ViewCompat.getWindowInsetsController(getWindow().getDecorView());
        if (windowInsetsController != null) {
            windowInsetsController.setSystemBarsBehavior(

WindowInsetsControllerCompat.BEHAVIOR_SHOW_TRANSIENT_BARS_BY_SWIPE
            );

windowInsetsController.show(WindowInsetsCompat.Type.systemBars());
        }

        // Initialize views
        Log.d(TAG, "onCreate: Initializing views");
        initializeViews();

        // Setup Map
        Log.d(TAG, "onCreate: Setting up map");
        SupportMapFragment mapFragment = (SupportMapFragment)
getSupportFragmentManager()
                .findFragmentById(R.id.map);
        if (mapFragment != null) {
            mapFragment.getMapAsync(this);
        } else {
            Log.e(TAG, "onCreate: Map fragment is null");
            Toast.makeText(this, "Error: Could not initialize map",
Toast.LENGTH_LONG).show();
```

```
        }

        // Initialize handler for periodic updates
        Log.d(TAG, "onCreate: Setting up periodic updates");
        handler = new Handler(Looper.getMainLooper());
        startPeriodicUpdates();

        Log.d(TAG, "onCreate: Activity creation completed");
    } catch (Exception e) {
        Log.e(TAG, "onCreate: Error during activity creation", e);
        Toast.makeText(this, "Error: " + e.getMessage(),
Toast.LENGTH_LONG).show();
    }
}

private void initializeViews() {
    try {
        totalAreaText = findViewById(R.id.totalAreaValue);
        deforestedAreaText = findViewById(R.id.deforestedAreaValue);
        forestHealthText = findViewById(R.id.forestHealthValue);

        // Setup RecyclerView
        RecyclerView alertsRecyclerView =
findViewById(R.id.alertsRecyclerView);
        alertsAdapter = new AlertsAdapter(this);
        alertsRecyclerView.setLayoutManager(new
LinearLayoutManager(this));
        alertsRecyclerView.setAdapter(alertsAdapter);

        // Initialize Geocoder
        geocoder = new Geocoder(this, Locale.getDefault());

        // Initialize SearchView
        searchView = findViewById(R.id.searchView);
        setupSearchView();
    } catch (Exception e) {
        Log.e(TAG, "initializeViews: Error initializing views", e);
```

```
        throw e;
    }
}


private void setupSearchView() {
    searchView.setOnQueryTextListener(new
SearchView.OnQueryTextListener() {
        @Override
        public boolean onQueryTextSubmit(String query) {
            searchLocation(query);
            return true;
        }

        @Override
        public boolean onQueryTextChange(String newText) {
            return false;
        }
    });
}

private void searchLocation(String query) {
    try {
        List<Address> addresses =
geocoder.getFromLocationName(query, 1);
        if (addresses != null && !addresses.isEmpty()) {
            Address address = addresses.get(0);
            LatLng location = new LatLng(address.getLatitude(),
address.getLongitude());

            if (mMap != null) {
                mMap.clear(); // Clear existing markers
                mMap.addMarker(new MarkerOptions()
                        .position(location)
                        .title(address.getAddressLine(0)));

mMap.animateCamera(CameraUpdateFactory.newLatLngZoom(location,
```

```
12f));
            }
        }
    } catch (IOException e) {

        e.printStackTrace();
        // Handle error - you might want to show a toast or snackbar
here
    }
}

@Override
public void onMapReady(GoogleMap googleMap) {
    try {
        Log.d(TAG, "onMapReady: Initializing map");
        mMap = googleMap;
        mMap.setMapType(GoogleMap.MAP_TYPE_SATELLITE);

        // Add custom styling to the map
        mMap.getUiSettings().setZoomControlsEnabled(true);
        mMap.getUiSettings().setCompassEnabled(true);
        mMap.getUiSettings().setMapToolbarEnabled(false);

        // Center map on Amazon rainforest with smooth animation
        LatLng amazon = new LatLng(-3.4653, -62.2159);
        mMap.animateCamera(CameraUpdateFactory.newLatLngZoom(amazon,
5), 2000, null);

        updateMapMarkers();
        Log.d(TAG, "onMapReady: Map initialization completed");
    } catch (Exception e) {
        Log.e(TAG, "onMapReady: Error initializing map", e);
        Toast.makeText(this, "Error initializing map: " +
e.getMessage(), Toast.LENGTH_LONG).show();
    }
}

private void startPeriodicUpdates() {
    updateData(); // Initial update
```

```
    handler.postDelayed(new Runnable() {
        @Override
        public void run() {
            updateData();
            handler.postDelayed(this, UPDATE_INTERVAL);
        }
    }, UPDATE_INTERVAL);
}

private void updateData() {
    // Update statistics
    double[] stats =
MockSatelliteDataProvider.getForestHealthStats();
    updateStatistics(stats[0], stats[1], stats[2]);

    // Update alerts
    List<DeforestationAlert> alerts =
MockSatelliteDataProvider.generateMockAlerts();
    alertsAdapter.setAlerts(alerts);

    // Update map markers if map is ready
    if (mMap != null) {
        updateMapMarkers();
    }
}

private void updateStatistics(double totalArea, double
deforestedArea, double healthPercentage) {
    // Animate the statistics updates
    animateTextChange(totalAreaText,
String.format(Locale.getDefault(), "%.1f", totalArea));
    animateTextChange(deforestedAreaText,
String.format(Locale.getDefault(), "%.1f", deforestedArea));
    animateTextChange(forestHealthText,
String.format(Locale.getDefault(), "%.1f%%", healthPercentage));


}
```

```
private void animateTextChange(final TextView textView, final String
newValue)

 {
    textView.animate()
            .alpha(0f)
            .setDuration(150)
            .withEndAction(() -> {
                textView.setText(newValue);
                textView.animate()
                        .alpha(1f)
                        .setDuration(150)
                        .start();
            }).start();
}

private void updateMapMarkers() {
    try {
        if (mMap == null) {
            Log.e(TAG, "updateMapMarkers: Map is null");
            return;
        }

        // Clear existing markers with fade-out animation
        mMap.clear();

        // Add new markers with animation
        List<DeforestationAlert> alerts =
MockSatelliteDataProvider.generateMockAlerts();
        for (DeforestationAlert alert : alerts) {
            LatLng position = new LatLng(alert.getLatitude(),
alert.getLongitude());
            MarkerOptions markerOptions = new MarkerOptions()
                    .position(position)
                    .title(alert.getRegion())
                    .snippet(String.format(Locale.getDefault(),
                        "Deforested Area: %.1f ha\nNDVI: %.2f",
                        alert.getArea(),
```

```
                        alert.getNdviValue()))
                    .alpha(0f);  // Start invisible


            Marker marker = mMap.addMarker(markerOptions);
            if (marker != null) {
                // Animate marker appearance
                animateMarker(marker);
            }
        }
        Log.d(TAG, "updateMapMarkers: Successfully updated map
markers");
    } catch (Exception e) {
        Log.e(TAG, "updateMapMarkers: Error updating map markers",
e);
    }
}

private void animateMarker(final Marker marker) {
    final Handler handler = new Handler();
    final long start = SystemClock.uptimeMillis();
    final long duration = 500;

    handler.post(new Runnable() {
        @Override
        public void run() {
            long elapsed = SystemClock.uptimeMillis() - start;
            float t = Math.min(1f, (float) elapsed / duration);

            // Apply an ease-out interpolation
            t = (float) (1 - Math.pow(1 - t, 2));

            marker.setAlpha(t);
```

```
         if (t < 1.0) {
                handler.postDelayed(this, 16);  // 60 FPS
            }
        }
    });
}
@Override
public void onAlertClick(DeforestationAlert alert) {
    // Center map on the clicked alert
    LatLng alertLocation = new LatLng(alert.getLatitude(),
alert.getLongitude());

mMap.animateCamera(CameraUpdateFactory.newLatLngZoom(alertLocation,
10));

    // Show alert details
    Toast.makeText(this, alert.getNotificationMessage(),
Toast.LENGTH_LONG).show();
}

@Override
protected void onDestroy() {
    super.onDestroy();
    handler.removeCallbacksAndMessages(null);









}
```

```
private void updateDeforestationData() {
    // Get the TextView for deforested area
    TextView deforestedAreaValue =
findViewById(R.id.deforestedAreaValue);


    // Format the deforested area with 2 decimal places
    String formattedArea = String.format(Locale.US, "%.2f",
calculateDeforestedArea());
    deforestedAreaValue.setText(formattedArea);
}

private double calculateDeforestedArea() {
    // Your existing calculation logic here
    // For now, returning a sample value
    return 156.75; // Sample value in hectares
}

@Override
protected void onResume() {
    super.onResume();
    updateDeforestationData();
    // ... existing code ...
}


}
```

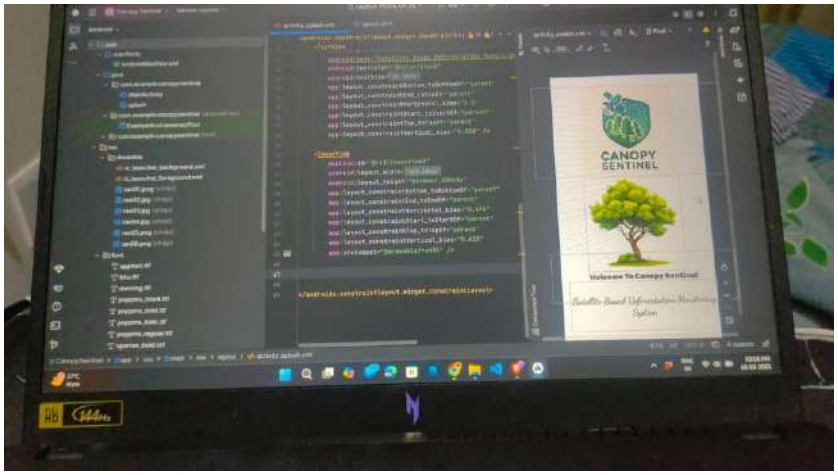
Appendix C: API Configuration Files

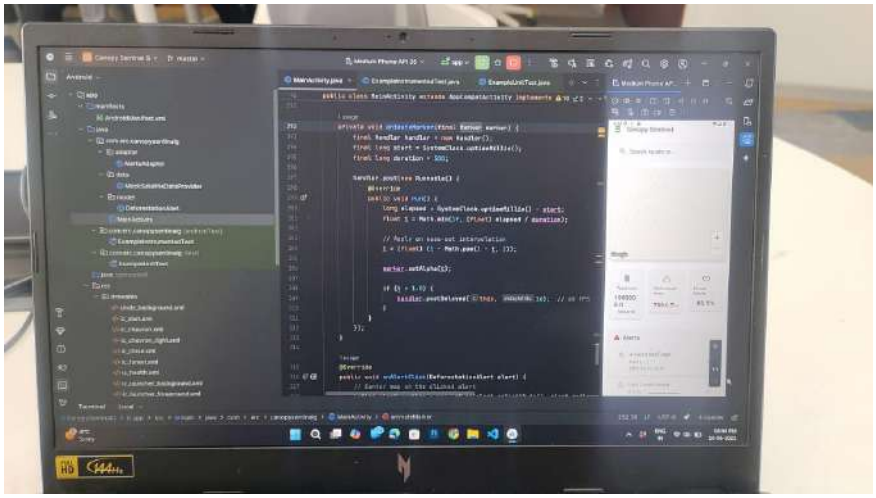
Technical specifications for API setup, including:

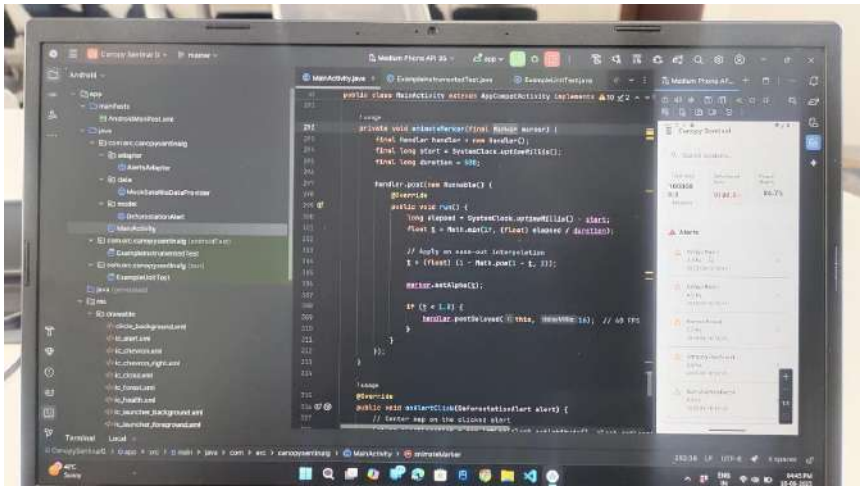
- Sample config.yaml/env files (with sensitive data redacted)
- Endpoint descriptions (methods, request/response examples)
- Authentication protocols (OAuth, API keys)

We have used API of GOOGLE JIO for this project since NASA API is paid, and Mapping is also paid.

PROOF WORK







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SENTINEL