Digital Tracking for Urban Trees and Plants

TreeTracker- Personalised Tracker for Your Trees

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***Abstract*:-Urbanization has resulted in the growing domestication of ecosystems and landscapes all over the world. Since the industrial revolution, cities have served as both engines of socioeconomic development and focal points for major environmental issues. Several studies have demonstrated that urban ecosystems and landscapes are on an unsustainable path. Cities are essential for global sustainability. In the transition to sustainability, urban ecology can – and must – play a key role. Human attitudes are a crucial component of urban social–ecological processes since they contribute to people's experiences with green space. To explain the relationships between people and urban trees, studies recording human attitudes toward trees are common in the literature. According to research, these people–environment relationships are dynamic, complex and make the exchanges that enrich and form one's awareness of the environment while also shaping the environment. Experiencing ecosystem disservices that contribute to disadvantageous human–nature relationships is one example of these experiences. This paper also highlights these urban/residential trees and their awareness while looking into semi digital alternate means to increase local consciousness of urban trees and increase the human-nature relationship in urbanized localities.**

Keywords: Urban ecosystem, Green spaces, Digital alternative

I. INTRODUCTION

Every year, more natural and agricultural lands are converted into urban areas. Cities are expected to house 66 percent of the world's population by 2050, up from 30 percent in 1950 [1]. Humans, animals, and plants all coexist in those regions. Dense houses, heavy traffic, construction work with deep excavation, and the widespread use of concrete and glass materials contribute to environmental degradation in terms of plant development. Unfavourable factors occur concurrently as a result of the dense buildings and restricted space for root growth [2,3] as well as upper branching, enhancing plant tension. Soil, rainwater supply, air, and light are all basic requirements for plants that are greatly modified compared to rural conditions [4,5]

The words "urban forests" and "urban trees" have been divided due to the unique localization of growth. An urban forest, according to Escobedo et al. [6], is the amount of all vegetation in a city area, including trees, shrubs, lawns, and previous soils. As per Roy et al. [7], an urban tree is "a woody perennial plant that grows in towns and cities." Individual trees and those growing in stands, patches, and groups in publicly accessible green spaces are included. While all trees are affected by the same set of stress factors in cities, the severity of these factors varies between individual growth stands. Roadside trees are most vulnerable to urban stressors resulting in their average lifespan being shortened.

Trees developing in grids and tree pits in the city are subjected to similar conditions. Park trees are less affected because they are subjected to mild stress [8]. Furthermore, due to the large number of people crammed into a relatively small location, all green spaces are extensively used. As a result, species selection must take into consideration the finer details of growth conditions, stress tolerance, and expected purpose. Trees cannot sustainably serve ecological functions if proper growth conditions are not provided.

II. OVERVIEW

A. *Urban Ecosystem and their unsustainability*

In present and shortly or over the next thirty years, the most population growth occurs or will occur in the big cities of many poor countries. While some of the Asian countries are seeing a dramatic downfall in the growth rates of their population, over three decades they are expected to see absolute growth of nearly a billion people all concentrated within the urban towns or cities. In some parts of Africa, the growth rate and development of urban cities are increasing rapidly. Africa is growing through a high-paced process of urbanization.

These Rapid growth rates in population and more and more people living and getting born in urban cities and towns lead to major unplanned and unsustainable patterns of urban development. These reasons then make these cities focal points of emerging environmental and health hazards.

As of now as the urban population grows the quality of the urban environment keeps decreasing and it is expected to see these patterns for many years. The quality of the Urban Environment plays a major role in public health.

For most of our human history, humans have been highly ignorant or less influenced by ecological systems, evolutionary changes, and biophysical processes as compared to the human influence on the “natural” or the non-human processes.

However, today humans affect a lot of the Earth’s ecosystem through the conservation of resources and land. Human Ecological Evolution has been generally attributing to natural variation in energy resources and material flows. Human’s effect on Earth’s ecosystem also includes alteration and species and habitats composition, disruption of the hydrological process.

In today’s urban era humans are said to be using more than half of accessible freshwater runoff and approximately

40% of global net primary production. In today’s date, at least half of the world’s forests have disappeared just because of human activities. Just because of moving predators around the world and hunting, humans have increased the extinction of many species to levels 1000 to 10,00 times higher than its “natural” or nonhuman causes.

Often unplanned and rapid urbanization leads to environmental degradation and these conditions lead to a risk to human health. One of the major problems caused by these major Urban Ecosystems and their lack of Sustainability is Air Pollution. Some data published by the World Health Organization (WHO) shows that 9 out of 10 people in the world breathe air that is rated the exceed their guidelines of pollutant air [9-13].

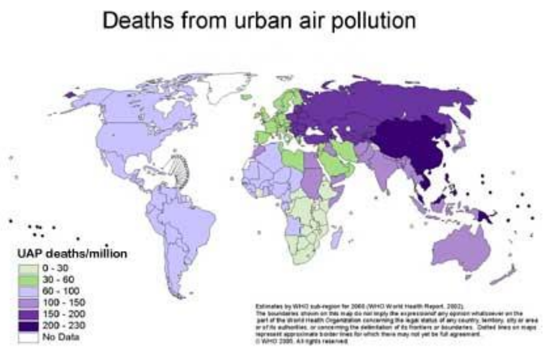
Deaths from urban air pollution
UAP deaths/million
0 - 30
30 - 60
60 - 100
100 - 150
150 - 200
200 - 230
No Data
Estimates by WHO sub-region for 2000 (WHO World Health Report, 2002).
The boundaries shown on this map do not imply the expression of any opinion whatsoever on the part of the World Health Organization concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries. Dotted lines on maps represent approximate border lines for which there may not yet be full agreement.
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Fig A. data showing deaths from urban air pollution.

B. *Humans and Green space*

The quality of the living environment, particularly in urban areas, has become an important issue for residents and a central theme in spatial planning [14]. The physical and mental health of citizens is impacted by polluted air, water, and climate quality, as well as decreasing availability of green space per capita [15-18]. As a result, urban planners and policymakers must address easy access and high-quality green spaces as part of a broader health promotion strategy [18].

In cities, contact with urban nature, such as public parks, promotes well-being and human health [19,20]. Access to green space relates to a higher likelihood of being physically active [18]. Furthermore, species diversity in a green area is viewed as a positive link to a stronger relationship with nature and higher site satisfaction [21]. Green space encourages its communities to return for its aesthetic ambiance and gives opportunities for gardening and leisure, which improves social cohesion within the community and can have a positive impact on health [22,23]. Furthermore, trees provide a variety of ecosystem services that lead to increased human well-being.

Modern urban living, and the persistence of environmental degradation, have resulted in problems for urban residents such as loneliness and decreased social contact. As a result, people need places where they can participate in social interaction while still meeting their psychological needs. Green spaces and natural heritage can help to enliven their often dull and gloomy surroundings. Urban green spaces and natural heritage will serve as agents and destinations for alleviating depressing modes in these settings.

The proximity of nature to the place of residency, reduced user stress, an increased variety of physical activities, enhanced morale of people, the opportunity to talk to friends, and the establishment of social connections among individuals occur in urban green spaces [24]. Green spaces can foster social cohesion or unity more than non-urban green parks. A city park is a gathering place for various ethnic groups to meet and converse, with these informal and formal encounters contributing to social cohesion [25].

It has also been argued that the nature of local green spaces and the image of green spaces in people's minds, coupled with the cultural characteristics of different ethnicities, provide opportunities for intercultural interaction. Green spaces, in reality, are one of the places that elicit a sense of social venue. These spaces enable people to learn from one another, express their personal and social values, and foster their spiritual development. In general, green space provides people with a sense of freedom and independence that is seldom available in the home or workplace.

III. Materials and Methods

A. *Tree Tracker App*

We are designing and developing an app known as TreeTracker which helps users to gain more knowledge about climate change and various other things and keep a track of their trees and plants.

The goal of this project is to form a connection with trees making us liable for their growth and hence have a personalized hand in reducing climate change. The main goal or the purpose which has driven this project is that we aim to reduce the gap between humans and nature by making people more aware of the happenings of climate change and create a special bond between humans and their plants.

This project was started initially as an idea that was spread out and then discussed out loud. Once we were clear with what we want with the project we started designing its features and initial skeleton and structure. The app’s design was initially designed in Figma. Figma: Figma is an open free designing tool where one can design their apps and websites.

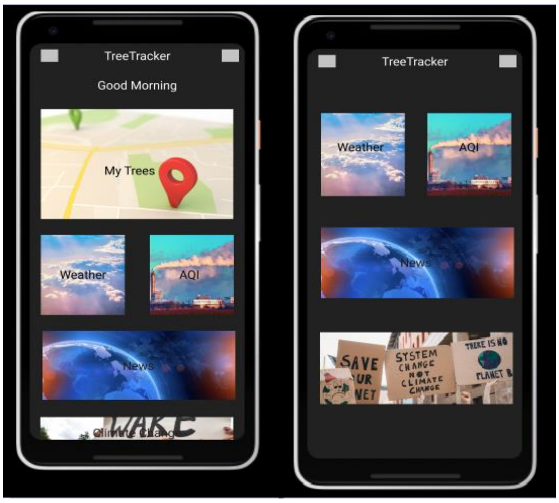


Fig B. Initial Design of the TreeTracker App

B. Tree Tracker Implementation

The TreeTracker App is a focused Android Project but because of the powerful and platform-independent tools, it uses behind the scene it can easily be implemented as an IOS Project as well.

TreeTracker is designed and completely written in Dart Programming Language. Dart Programming Language has many advantages. It is a Client-Side Rendered Language, so no Server-Side Rendering is required. Dart is a class-based, Object-Oriented Programming Language which means it handles various data types and objects well and also can implement various concepts like Inheritance, Polymorphism, etc. Along with that Dart Programming Language can be used on various platforms which include everything from mobile operating systems to desktop-based operating systems as well as web.

As TreeTracker has a strong programming language for support. It also has a strong and powerful UI Framework that runs on the Dart Programming Language- Flutter. Flutter is a UI Kit that can develop apps on various platforms that include Android, IOS, Windows, macOS, Linux, and Web. Flutter helps in building beautiful apps that run on multiple platforms by using just one codebase. Dart provides a great backend to Flutter and Flutter provides beautiful UI and Scalability to Dart so this Framework and Programming Language both perfectly go hand in hand. Dart and Flutter both are open-source and are maintained by Google.

TreeTracker now has a stable and powerful programming language and a powerful and customizable Framework for designing and development. After having all this we needed a stable host and database as we needed to store our user data. As we needed to store our user's data, we needed an online hosted database. Along with that we also needed an easy way for user authentication and managing authentication secularly is particularly important. So, we went with Firebase for this. Firebase is an online-based hosting platform that offers many features to developers building mobile apps and websites. Firebase provides various features like Authentication, Online NoSQL DataBase: Firestore, and many more. Firebase is also developed and maintained by Google and it goes and works very well with Flutter. Firebase and Flutter is a stack designed to go perfectly with each other and when used together it is known as FlutterFire. FlutterFire makes it quite easy for developers to implement many complex features.

While developing TreeTracker we used various other tools as well to make our work more efficient. The IDE or the Interactive Development Used are Android Studio and VSCode. As Android Studio is well known for its great features enabling android developers to develop android apps efficiently it was indeed a helpful tool. Along with that VSCode, one of the most famous and most IDE also had many helpful features and extensions that helped us through the development cycle.

Git was the tool we used for source control for our code. Git is a powerful development tool that helps to track the development cycle of any code or any type of file. We can commit the changes made and also revert to the commits which were made before.

As we used Git for source control, we also needed something that enables us to write code collaboratively and merge various codes and written by various people on various machines. We used GitHub for having our code out in public and to help us be collaborative.

As this project also uses some of the Web RESTful APIs, we took the help of Postman for testing and Implementing those APIs. The Postman is a tool that lets one use and tests various APIs by making it to send all types of requests and presenting the response of the APIs easy to read.

Along with all the above-mentioned tools, there were many built-in and open-source libraries in flutter which were a lot helpful during development.

C. Tree Tracker Features

1) Authentication Feature: Having an easy and secure authentication system is important in today's era of computers. As mentioned earlier we have used FlutterFire or Integrated Firebase with along with Flutter for this feature. Firebase offers many ways of authenticating users to your project i.e., Giving standard email password Sign-In method or Providing OAuth Sign-In in form of different OAuth providers like Google, Microsoft, GitHub, Play Games, Facebook, Twitter, Yahoo, etc. For our project, we decided to go with Sign-In with Google option as it is the easier way to Sign-In and the user does not have to enter or remember any passwords and as also this an Android App user will already be Signed-In through his/her Google account, they just have to give the app to permission to Sign-In with their Google Account. The dependencies used for this feature are:

- firebase_core: An important dependency used whenever Flutter apps are to be initialized with FireBase. This dependency helps to initialize or connect Firebase to our app using Flutter.
- firebase_auth: This is the dependency that handles all the authentication done using Firebase Authentication. This is an important dependency as well as it tells the app about the current unique user of the app.
- google_sign_in: Another important dependency used to handle the Google OAuth Provided by the firebase_auth dependency

a) Working of the Authentication Feature:
The Authentication Feature is The First thing the App runs once it starts. Once the App Run it depends on the firebase_core dependency to initialize firebase and then depends on firebase_auth dependency for checking if there is a current Signed-In user to the app or not. If the user is not Signed-In then the user will be shown the Login Screen, where he or she is supposed to choose their Google Account for Signing-In. Once the user chooses the Google Account the App will call the Firebase Auth API and wait for it to respond back with the user's information. Once the app receives the response the user will be redirected to the Home Screen. If the user is already Signed-In then the User will be Directly be taken to the Home Screen of the App and won't see the Login Screen.

b) Logout in Authentication: The User can Log Out from the app through the Home Screen. Once the user presses the Log Out Button the App Notifies the Firebase Auth API and Signs the user out and exits the App.

2) The Home Screen: The Home Screen is the Main Hub or a Navigation Point of the TreeTracker App. The Home Screen is the one that opens once a Signed-In user Opens the App. The Home Screens Serves as a Route to all the other Features of the TreeTracker App. The Home Screen is designed in a List Format. Major things while designing the home screen where to keep the User Experience simple and easy to use and User Interface be interactive and attractive.

3) NewTree Feature: This Feature Lets the User add a tree to his gallery. Any tree or plant user adds will be stored in an online database. The user has to access his camera through the TreeTracker app and click a live image of a tree or a plant. By storing this plant, he will be able to track its growth throughout its lifetime. While adding a new tree the App also asks the user to add a nickname for the tree. Along with that the app automatically fetches Users current location while adding the tree, marking the location of that tree.

All this information the location of the plant, its nickname, and its image is then processed and then securely saved to a database. As the following Feature does many things like capturing location and capturing Live Image it also requires many dependencies which are listed below.

- image_picker: This dependency is used to access the default Camera App of the User's device. It captures the image and then processes it to the internal code of the app.
- path_provider: This dependency defines the path of the image when it is captured. Once the image is captured it is stored in a temporary path until it is uploaded which is defined by this dependency.
- uuid: This dependency is used to give a unique Post Id to each post before it uploaded to the database
- image: This dependency is used to compress the image before it is uploaded.
- geolocator: This dependency is used to get the current location of the user. The return value of this dependency is the Latitude and Longitude of users' current location.
- firebase_storage: This is a storage dependency. It is used to upload and store files in FireBase Storage Cloud. Any type of File can be uploaded to the cloud using this dependency.
- cloud_firestore: This is the dependency that sends all our data to Firebase NoSQL Database Firestore in SchemaForm which includes documents and collections of data.
- firebase_auth: This dependency is used to get the currently logged-in User of the App.

a) Working of the NewTree Feature and the Database Schema: Whenever the user Enters the New Tree Feature Screen, he is greeted with a button that says Add Tree. Once the user clicks on that button the App invokes the phone's inbuilt camera for clicking a photo of the Tree. This is made possible by the image_picker dependency. Once the user captures the image of the Tree, he is Redirected to the Upload Screen. While Redirecting the image is stored in a temporary path on the user's device. This path is provided by the path_provider dependency. Then this path of the image transfers the image to the App's Code in File Datatype. Once the redirect to the Upload Screen is complete the user will be able to see the Upload Screen. The Upload Screen Consists of The Preview of the Image user just clicked a text field for the user to fill in the nickname of the plant. While the user does this the app automatically captures the user's current location where he has captured this image so that we can get the area where the plant is located. This process of fetching the user's location is made possible due to geolocator dependency which returns the latitude and longitude of the user's current location.

Once the User is done previewing the image and adding a nickname for his plant, he can press on the Upload Button Provided on the Upload Screen. Once the user presses the Upload Button behind the image is uploaded on the Firebase Storage Cloud using the firebase_storage dependency. Once the image is uploaded its Unique URL on the Cloud is returned to the program. Now that the image is hosted online on the cloud, we need to store the link of the image and all other data in the Database. As the database we are using is a NoSQL Database we need to create a Scheme of the Database in the form of documents and collections. As the App uses one Common Firestore Instance for all the users we need the App to differentiate between all the user's data as all users have their own unique data.

So, the We create a Collection named 'Trees' which stores all the data of all the users. Then for differentiating all the user's data we make a document for each user. This document name needs to be unique for each user, so we take advantage of the Firebase Authentication's feature of giving each user of the app a unique User Id. We fetch the current user and then get its User Id and then create a document for the name of that User Id.

'Trees' => Unique User Id

Inside the User Id directory, we create a new collection name 'userPosts' which stores all the 'userPosts' or all the plants the user will add throughout the time of using this app. All these post names also need to be unique, so we use uuid dependency to create a unique Post Id for all the posts.

'Trees' => Unique User Id => 'userPosts' => Unique Post Id

Now the post has its own document we can easily add to store the data about the plant within snapshots. This snapshot contains all the data about the current post or the current plant. Initial Image URL, Nickname of the Plant, the Latitude and Longitude of the Plant and the time this data was added.

'Trees' => Unique User Id => 'userPosts' => Unique Post Id => Data About the Current Plant

Now, the initial data is set. Users can also add more images to the current plant, so we need to take care of that as well. We need a collection for storing all the images for this current document or the current plant. We create a new collection named ‘allImages’ inside the Current document of Current Unique Post Id. This document stores snapshots of all the images ever going to be added in this plant in the document named after the image that is stored in the cloud.

‘Trees’ => Unique User Id => ‘userPosts’ => Unique Post Id => ‘allImages’ => ImageName => ImageData

Once all these Schemas are designed, they are sent to Firestore Instance using the cloud_firestore dependency which then calls its API and does all the changes in the database. Once everything uploaded on the cloud and the databases are updated the User is redirected to the Home Screen and the user will be able to see his newly added Tree in the MyTress Screen.

4) MyTress Screen: This Screen is where the user can keep a track of all his plants and trees, he has ever captured in the TreeTracker App. As all our data is stored in the online Database, we need to get that data first and then display it on the Screen. This screen consists of two things. Google Maps Portion to show the Location of the Plant and a List to List down all the plants. If the user Long Presses on a Particular Plant on the List the Google Maps section will zoom into that plant's location on the Map. If the user taps or clicks on a particular plant on the List, then he will be taken to the individual photo gallery of that particular plant. This feature also requires a lot of dependencies which are listed below:

- cloud_firestore : to retrieve the data from our FirestoreOnline Database.
- google_maps_flutter: to show the Google Maps Instance on the Screen and Plot the Plants Location on the Map.
- firebase_auth: to get the details of the current user of the app.

a) Working of the MyTrees Screen: When the Home Screen Directs to this Screen the first thing the app does is Fetches the Information from the Firestore Database. As the data in Firestore is stored in the form of collections and documents we need to call the current user's document and then fetch all the ‘userPosts’ from it. At first, we call the Firebase Authentication Function to get the current user and his unique User Id. Then we run the fetch statement on the Firestore for the collection ‘Trees’ in that searching the document named after our Users Unique User Id and then the collection ‘userPosts’ and get all the snapshot data of that collection.

‘Trees’ = > Current User Id = > ‘userPosts’

Once all the data is fetched it is checked if the data is NULL or not. If the Data is NULL, the user is informed that he or she does not have any Tree or plant yet and can get started by adding a new one.
If the data is Not NULL, then the Snapshots are gone through and all the userPosts or the user’s plants are fetched and listed down in a List. Along with that the data is also taken to the google_maps_flutter dependency which takes the latitude and longitude part and plots down all the trees or plants on the Google Maps Screen. The Google Maps Screen and the list which lists down all the plants have a 4:3 aspect ratio of the whole screen defined by the user’s device.

b) OnTap Functionality: Whenever the user clicks on any plant on the List it is redirected to the Image Gallery Screen for that plant. While Redirecting it passes the Unique Post Id of the Plant whose gallery we are getting redirected too.

c) OnLongPress Functionality: Whenever user long presses on the List the Google Maps Controller used to Control the Current Position map is displaying zooms in on the pressed plant’s location

5) View Gallery and Update Image Feature: This screen implements two features in one which is displaying a photo gallery for a particular plant and also being able to update and add a new image in that photo gallery. This is an important screen for the app because this helps the user to keep track of the tree’s growth throughout a time period. Dependencies involved for the screen are displayed below:

- image_picker: This dependency is used to access the default Camera App of the User’s device. It captures the image and then processes it to the internal code of the app.
- path_provider: This dependency defines the path of the image when it is captured. Once the image is captured it is stored in a temporary path until it is uploaded which is defined by this dependency.
- image: This dependency is used to compress the image before it is uploaded.
- firebase_storage: This is a storage dependency. It is used to upload and store files in FireBase Storage Cloud. Any type of File can be uploaded to the cloud using this dependency.
- cloud_firestore: This is the dependency that sends all our data to Firebase NoSQL Database Firestore in SchemaForm which includes documents and collections of data.
- firebase_auth: This dependency is used to get the currently logged-in User of the App.

a) Working of the Image Gallery Feature: This feature or this screen when called receives a parameter that is the unique Post Id for the plant or tree whose gallery is to be displayed. So once this screen is called the app goes and fetches all the data for the collection of that Post Id including the ‘allImages’ collection which contains all the Image URLs for the images that are to be displayed in the Gallery View. Once all the data is Fetched from Cloud Firestore all the images are presented on the user's screen to form an image gallery of that plant. This image gallery consists of all the images that the user has taken and stored of that particular plant or tree on the TreeTracker App.

Data Fetched: ‘Trees’ => Current User Id => ‘userPosts’ => retrieved Post Id => ‘allImages’

b) Working of the Update Image Feature: This feature is almost working like a new tree feature but has some modifications. Once the user clicks on the update picture the image_picker dependency invokes the inbuilt camera of the user’s device. Once the user clicked the picture the image is passed on the program in a variable of File data type and the user is redirected to the upload screen. The Upload screen consists of the image preview and an upload button. This time the location and the nickname of the plant is not needed as an input as we are updating an existing plant, so that data already exists.

Once the User Clicks on the Upload Image Button the image is taken and uploaded to Firebase Storage and it returns its cloud hosted URL. This all is made possible by the firebase_storage dependency.

The image URL needs to be saved in Firestore. This time we will add data in an existing snapshot as we have to add a new dataset to an existing dataset.

We add this snapshot under the ‘Trees’ collection inside our user’s User Id document and then ‘userPosts’ Collection, the document we need to go with is the Post Id passed to us while invoking this screen. Inside the Post Id document in images collection, we will add a new Snapshot of data of our image’s name which is stored on cloud and store its URL inside it.

Trees => Unique User Id => userPosts => Unique Post Id => allImages => ImageName => NewImageData

6) Weather and AQI Feature: Although these two are two different screens and things the functionality they provided in the way they provide is almost identical in our app. These Screens are used to say Weather and AQI around user’s are, respectively. These both features are dependent on an external RESTful Web API provided by OpenWeather.

Dependencies that these screens have are listed below:

- convert: To convert the Response Type of the API to JSON Format
- http: To perform http based or web-based actions
- geolocator: This dependency is used to get the current location of the user. The return value of this dependency is the Latitude and Longitude of users’ current location.
- geocoding: This dependency takes its input as Latitude and Longitude and gives out the Exact Location based on its Input. The output can be classified into city, state, and country.

a) Working of the Weather and AQI Features: These two features are two different screens and so are listed differently in this home screen. However, their functioning is the same. Whenever the user opens any of these screens his location is fetched using the geolocator dependency, and we get the output as Longitude and Longitude. Once we have users Latitude and Longitude, we can pass it to the OpenWeather API. This is a Free Web RESTful API. The API calling and its response is handled by the http dependency.

If the response received by the API is 200 then it is converted into JSON format using the convert dependency.

Meanwhile the geocoding library or dependency is used to convert the user’s Latitude and longitude to his or her city name to be displayed on the output screen. Once all the output is parsed from the converted JSON it is presented on the Screen Showing all the necessary and relevant data for both the topics Weather and AQI around the User's Current Location.

7) News Feature: This feature has the aim to provide the user basic and latest News Article about Climate Change and on the ongoing things happening around the world around it. Dependency this feature holds are:

- WebView flutter: This dependency helps open web pages inside our Flutter app without using any external browser.

a) Woking of the News Feature: TreeTracker is Highly Dependent on Google News Feature for all the news sources for all the News about Climate Changes. This Feature uses webview_flutter dependency to open the Google News Page for Climate Change which holds all the latest News articles and Information about Climate Change.

8) Climate Change Screen: This Screen is a Feature but also an educational page of the app where we have compiled basic and all the important information about Climate Change a Person Needs to Know. This Screen is predefined, and the data shown is predefined in local variables of the app. It is more like a Must-Read Article About a Climate Change. This article is compiled information of multiple resources merged and made easy to understand for all the users.

IV. SKILL LEVEL, TIME PERIOD, ACHIEVEMENTS AND RESULTS:

This project requires a Medium Skill Level in Programming Concepts and understanding of Mobile Development. Major things to keep in mind while developing were that no feature or a bug should break the whole app or cause an inconvenience neither to a user nor to the app. Also, the app needed a stable and usable User Interface which should work on the Screen Sizes and should not have limitations on working on certain devices.

Major Skills Required For this Project were:

- Integrating Firebase: The Authentication, NoSQL Database and Cloud Storage Provider for our app.
- Implementing APIs: This App is dependent on many exterior APIs for many features including Google Maps, Weather, AQI etc.
- Using NoSQL Databases: This App is fully dependent on NoSQL Databases of Firebase: Firestore. Use cases of documents and collections was a major part of this project

- Implementation of Dependencies: Implementing Camera and Location Dependency is one of the major parts of this project.

Time Period for development of the TreeTracker App took around 2 months and a lot of hard work and dedication to have an impact on the environment and educate more and more people about the ongoing things around taking from Climate Change and Pollution to Modern Problems of Urbanization.

The major achievements of the TreeTracker App are to complete all the goals we had set while starting this project. Other Achievements include:

- Having Secure and Easy Authentication Service: Signing in Google is Considered to be one of the safest and easiest way to Sign-In to an app in an Android Device
- Writing Clean and Reusable Code: We were able to write Clean, Reusable and Readable Code during the Development of this app which will help us in the future, while making updates to the app or the project.
- Easy Addition of new Features: As we are all the features are self-dependent, we can easily add new features to this app in the new future.

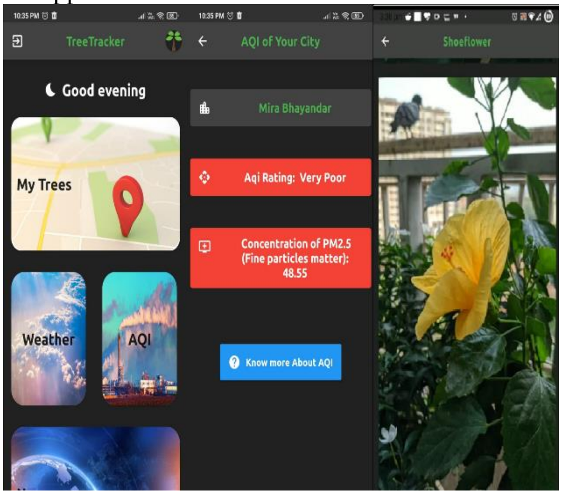


Fig C:

Showing Home Screen AQI Screen, Photo Gallery Screen

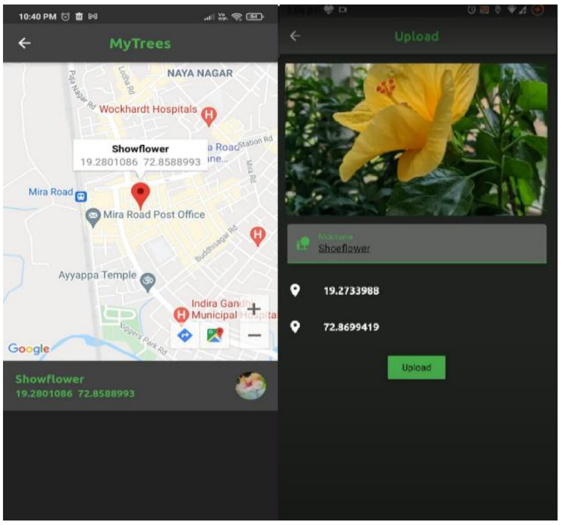
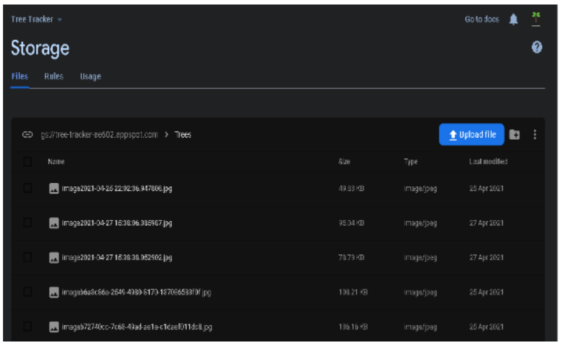


Fig D:

Showing User Location with Google Map Implementation and the Upload Screen



gs://tree-tracker-ae602.appspot.com > Trees

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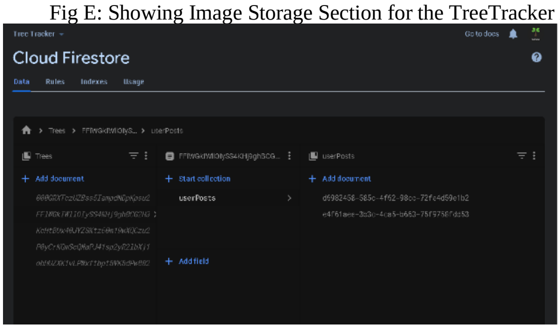
image2021-04-27 16:38:38.052902.jpg	78.79 KB	image/jpeg	27 Apr 2021
imageb6a8c86a-2649-4980-8170-187096538f0f.jpg	108.21 KB	image/jpeg	25 Apr 2021
imageb72740cc-7c68-49ad-ae1e-c1daef011dc8.jpg	186.16 KB	image/jpeg	25 Apr 2021

Fig E: Showing Image Storage Section for the TreeTracker App



Trees > FFlWGkIWlOlyS... > userPosts

Trees	FFlWGkIWlOlySS4KHj9ghSCG...	userPosts
600GRXTczUZBss5IampdNDpKosu2	userPosts	d6982458-585c-4f62-98cc-72fe4d59e1b2
FFlWGkIWlIOlySS4KHj9ghBCG2H3		e4f61aee-3b3c-4ca5-b663-75f9756fdd53
KcHtBUx40JYZSKtz60m19wXQCzu2		
P0yCrKGnScQMaPJ41sp2yR21bXj1		
ob9UZXK1vLPNxf1bpt5VK5dPw892		

Fig F: Showing NoSQL Firestore Database of the App

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