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Android App for Argo Floats

R U V N Satish, M Vivekananda Swamy, TVS Udaya Bhaskar, M S Girish Kumar

Indian National Center for Ocean Information Services
(Ministry of Earth Sciences, Govt. of India)
Hyderabad
www.incois.gov.in

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R U V N Satish, M Vivekananda Swamy, TVS Udaya Bhaskar, M S Girish Kumar

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Abstract

INCOIS has deployed more than 400 Argo floats till now and soon reaching a special milestone of 500 Indian Argo floats. In this context there is a necessity to have a unique application by which scientists can effectively and efficiently track all the information of these floats and also monitor the active floats among them regularly. The present work describes about an Android application or app which eases the work of researchers to track the information of these Argo floats as well as monitor them regularly. This app is designed and developed to give all the information related to Argo floats like its various types, its deployed positions, its current positions, its functionality, search option, etc., in the form of maps and charts in turn uses real time data to give latest status of Argo floats. In addition to it, this app is also useful in advising the scientists involved in Argo program about the floats in danger of getting grounded or beached that need immediate attention. This app is a very useful tool for the scientists to check the current status of Argo floats from anywhere or anytime using a smart phone.

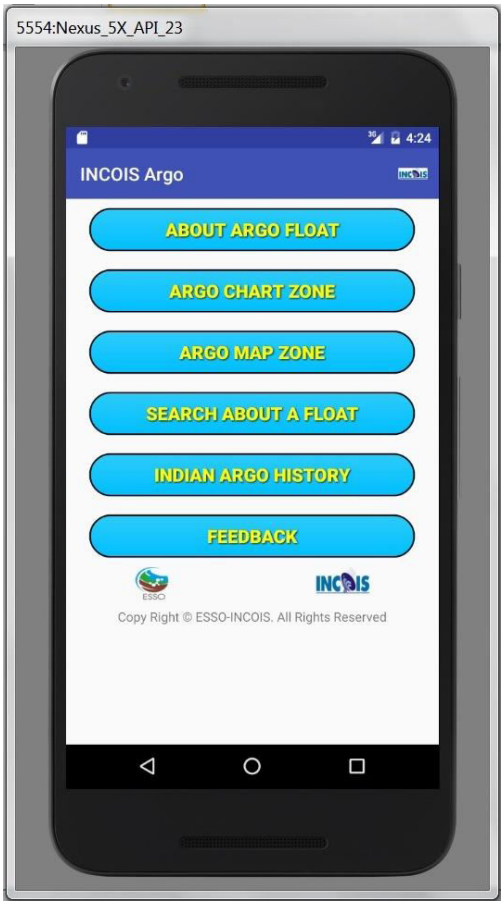

Figure 1: Argo Android App main activity display screen.

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Abstract

INCOIS has deployed more than four hundred Argo floats till now and soon reaching a special milestone of five hundred Indian Argo floats. In this context there is a necessity to have a unique application by which scientists can effectively and efficiently track all the information of these floats and also monitor the active floats among them regularly. The present work describes about an Android application or app which eases the work of researchers to track the information of these Argo floats as well as monitor them regularly. This app is designed and developed to give all the information related to Argo floats like its various types, its deployed positions, its current positions, its functionality, search option, etc., in the form of maps and charts in turn uses real time data to give latest status of Argo floats. In addition to it, this app is also useful in advising the scientists involved in Argo program about the floats in danger of getting grounded or beached that need immediate attention. This app is a very useful tool for the scientists to check the current status of Argo floats from anywhere or anytime using a smart phone.

Figure 1: Argo Android App main activity display screen.

1. Introduction

1.1 What is Argo?

Argo is an international project which is conducted in cooperation with meteorological and oceanographic organizations of many nations, WMO and IOC[1]. Argo floats play a vital role in understanding the behavior of the oceans. Argo is a global array of more than 3,000 free-drifting profiling floats that will measure the temperature and salinity profiles of the upper 2000 m of the ocean after deploying them. These floats are like semi-robotic probes which work on the principle of hydraulics. Today at least one Argo Float is in every 2 degree by 2 degree latitude and longitude of five oceans on the earth. Argo will allow continuous monitoring of the climate state of the ocean, with all data being relayed and made publicly available within hours after collection and transmit those data via the ARGOS satellite system every 5/10 days. Argo float measures the parameters like Temperature, Salinity, Pressure, Dissolved Oxygen, Chlorophyll, pH, Nitrates etc., during its 5/10 days cycle in which it profiles up to 2 km down the ocean from its surface. After deployment of these floats, they collect data and send it through satellite every 5/10 days and again collect data and send it back, this is a continuous life cycle of a float. This life cycle can come to an end due to battery drainage, beaching, grounding or many other unknown reasons. Some of these reasons like beaching and grounding can be avoided by constantly monitoring the floats

With the completion of Argo float network consisting of 3000 floats in 2007, one lakh T/S profiles in the global ocean are being reported every year. The present status of number of active Argo floats deployed by 26 nations and European Union together in the world ocean is more than 3500. India is one among these nations and played a pivotal role in building this global Argo network. Indian National Centre for Ocean Information Services (INCOIS) is an organization which is responsible for performing and managing Indian Argo program, and as of November, 2016 contributed 401 floats to the global Argo float network among which 136 floats are active. The data of Argo float is distributed to meteorological organizations around the world via the Global Telecommunication System (GTS) within 24 hrs. after reception and served to observe the oceanic state and to forecast climate changes. The data thus obtained is used in studies related to enhancing the existing Indian Ocean climatologies[3], inter-annual to intra-seasonal variability of salinity[4], variability of mixed and sonic layer[5], oxygen minimum zones[6], ocean state during pre and post cyclones[7] and many more. Conceptually, Argo builds on the existing upper-ocean thermal

networks, extending their spatial and temporal coverage, depth range and accuracy, and enhancing them through addition of salinity and velocity measurements[2].

Therefore it is essential for end users to have a unique application where information tracking of all the deployed Argo floats and also monitoring them can be done on regular basis. Thus we have designed and developed Argo Android app, which serves this purpose effectively and efficiently.

1.2 What is Android?

Android is the name of the mobile operating system based on Linux kernel which is released on 05 November, 2007 and owned by American company, Google. Though it has not even completed ten years mark, it has spread more rapidly than any other mobile operating system. It is commonly designed for the touch screen mobile devices like smartphones, tablets, table computers, specialized user interface for Android TV and Android enabled vehicles. These Android devices from a host of manufacturers offering users access to Google's own services like Search, YouTube, Maps, Gmail and more. This means one can easily look for information on the web, watch videos, search for directions and write emails on your phone, just as you would on your computer, but there are even more services are offered by Android than these simple examples.

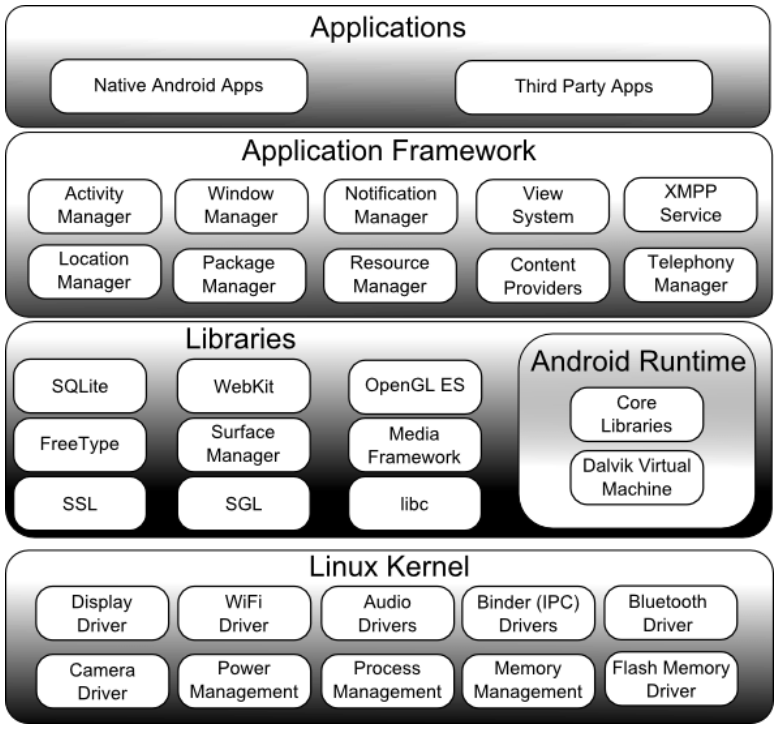

Figure 2: Main Components/Architecture of Android Platform.

Android is an open source, Linux-based software stack created for a wide array of devices and form factors. The above diagram Figure 2 shows the major components of the Android platform. Android is architected in the form of stack which is divided into five sections and four different layers as shown in Figure 2.

Android architecture or Android software stack is categorized into five parts:

i. Linux Kernel
ii. Native Libraries (Middleware),
iii. Android Runtime
iv. Application Framework
v. Applications

Each layer of this stack, and the corresponding elements within each layer, are tightly integrated and carefully tuned to provide the optimal application development and execution environment for mobile devices in a user-friendly way.

1.3 What makes Android so Special?

Android powers hundreds of millions of mobile devices in more than 190 countries around the world. It's the largest installed base of any mobile platform and growing fast. Every day more than one million new Android devices are activated worldwide. A Survey suggested that nearly eighty percentage of worldwide and ninety percentage of Indian, smart phone sales to end users by Operating System belonged to Android OS. Android phones are highly customizable smart phones which simplifies complex and tiresome tasks by showing a simple solution in a smart way. One can download Android applications or apps to do all sorts of things like manage your bank account, pay bills, read news, shopping, mobile recharge, order food, check your Facebook and Twitter feeds, play games etc. You can plan events from your phone's calendar and see them on your computer or browse websites on your desktop Mac or PC and pick them up on your phone. The benefit of this is that if you lose your phone all of your numbers will be saved. The next time you get an Android phone (or an iPhone or Windows Phone if you prefer) and sign in with your Google Account, all of your contacts and friend's numbers will be displayed in your new phone's address book immediately, no need to transfer or back them up anywhere else. Syncing is a way for your phone to keep all your information; websites, contacts, calendar entries and apps up-to-

date. This can happen over your phone's mobile data or Wi-Fi connection, seamlessly, in the background.

The following are the main advantages of Android OS:

i. Android is open - Because it is Linux based open source, it can be developed by anyone.
ii. Multitasking - Android phones can run many applications in a single instant.
iii. Easy access to huge Android App Market - Android users can avail the services of different apps for free from Google play store which contain many number of apps that serve our purpose.
iv. Can install a modified ROM – Unlike other mobile operating systems, Android users can even customize their ROM that is used on Android mobile and guaranteed it will not harm the device.
v. Phone options are diverse – Android OS is different than the IOS, because IOS is limited to the iPhone from Apple but Android is available on mobile phones from various manufacturers.
vi. Ease of notification - Any SMS, Email, or even the latest articles from an RSS Reader, there will always be a notification on the Home Screen of Android phone.
vii. Widget – With the help of variety of widgets present on the home screen of mobile, users can easily access various settings quickly and easily.

1.4 What are Android Apps?

Android applications are usually developed in the Java language using the Android Software Development Kit (SDK). The Android SDK tools compile your code along with any data and resource files into an APK, an Android package, which is an archive file with an .apk suffix. One APK file contains all the contents of an Android app and is the file that Android-powered devices use to install the app. There is an easy access to thousands of Android applications which are usually available in Google Play Store, in the Amazon App store and on various Android App-focused sites, and these apps can run on Android smartphones, tablets, Google TV and other devices. These apps are easily portable on any Android smart phone. Android apps can be either freely downloadable or premium; these premium apps are available for purchase by users, with revenues for the latter shared between Google which takes only thirty percent of income and the

software developer will be given remaining seventy percent of income. Additionally, some Android Apps follow the freemium business model, wherein the app developer can derive revenue on free apps via Google's in-app billing capabilities.

1.5 Argo Android App

Keeping this ubiquitous use of Android apps in mind, Argo Android App is developed for the Argo floats. The primary objective of this app is to provide a tool to assist the scientists working on Argo floats. This app is easily portable on any Android smart phone. The main purpose of this app is to ease the work of researchers to track the information of these Argo floats as well as monitor them regularly. This app is designed and developed to give all the information related to Argo floats like its various types, its deployed positions, its current positions, its functionality, its different statistics, search option, etc., in the form of maps and charts in turn uses real time data to give latest status of Argo floats. There is also an option to search for a float using some key terms. In addition to it, this app is also useful in advising the scientists involved in Argo program about the floats in danger of getting grounded or beached that need immediate attention. This app is a very useful tool for the scientists to check the current status of Argo floats from anywhere or anytime using a smart phone. Argo Android app saves the time of researchers in helping them choose the data from best set of Argo floats available in the region where his research is focused. This app is a complete package for regular monitoring of Argo float devices even in the challenging location like in ship, coastal areas, etc., just with the availability of internet in mobile.

The main activity display screen of Argo Android Application is shown below in Figure 3. From the below figure it is clear that there are six main blocks/modules in Argo Android App which provide major service activities to the end user. They are as follows:

i. About Argo float
ii. Argo Chart Zone
iii. Argo Map Zone
iv. Search about a float
v. Indian Argo history and
vi. Feedback.

These six main modules/blocks contain few sub-modules which provide the required activities to the end user as per his requirement. In the next section the contents of these six modules and their sub-modules are discussed in depth.

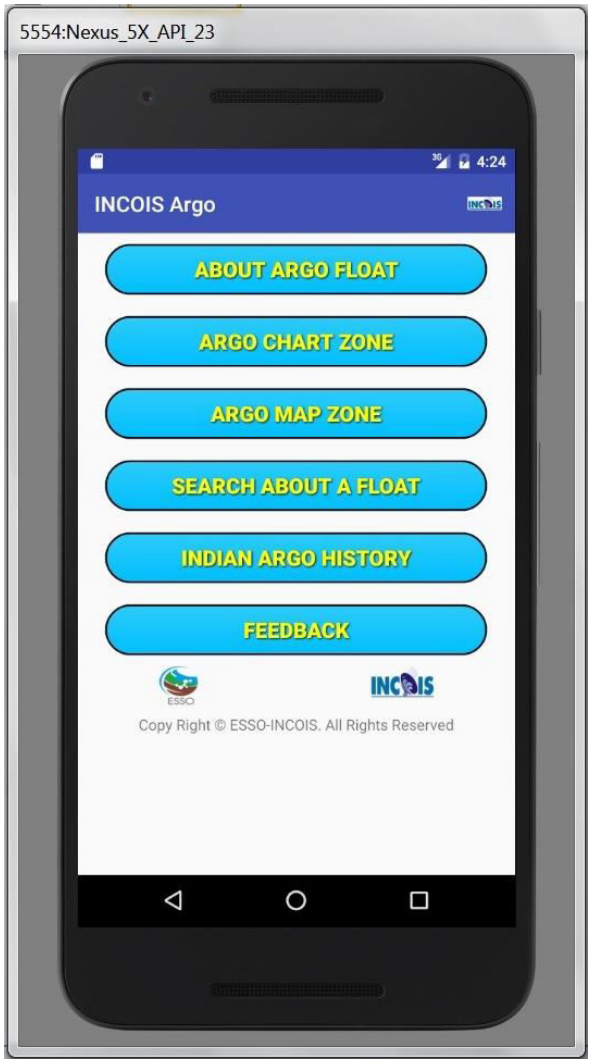

Figure 3: Argo Android App main activity display screen.

2. System Development

In this section we will discuss the complete system development. Argo Android App is designed and developed using Android Studio[8] and the database used in this system is SQLite which is installed in default in any Android device. Most of the charts are generated with the help of Android library known as "MPAndroidChart[10]". It is a powerful Android chart view/graph view library, supporting line, bar, pie, radar, bubble and candlestick charts as well as scaling, dragging and animations. This app does not require any other things to be installed, it is ready to use in any

Android device. This Android app is mainly developed to serve the scientific community who are doing their research on oceans with the help of data from Argo floats. This application shows tracking of the information of Argo floats which are deployed in Oceans for understanding the Ocean behavior by measuring the parameters like temperature, salinity, pressure, oxygen etc., The brief discussion on system overview using its context level diagram and system architecture as follows.

2.1 System Overview

The Android application that is designed and developed for the purpose of Argo floats and which is described in this article is named as Argo Android App. This system compromises mainly two users who are admin user and end user. The Admin user is the administrator of the app who created the app and maintains the app up to date on timely basis through updated patches. The end user is the user who receives services of this app for his research, monitoring or other purposes. This app is developed with a primary motive of designing in a user-friendly way. All the services provided by this app serve the purpose of end users as per their requirement. The below Figure 4 is the context diagram or the level 0 diagram of Argo Android App, which clearly depicts the main actions performed by both the users in this system.

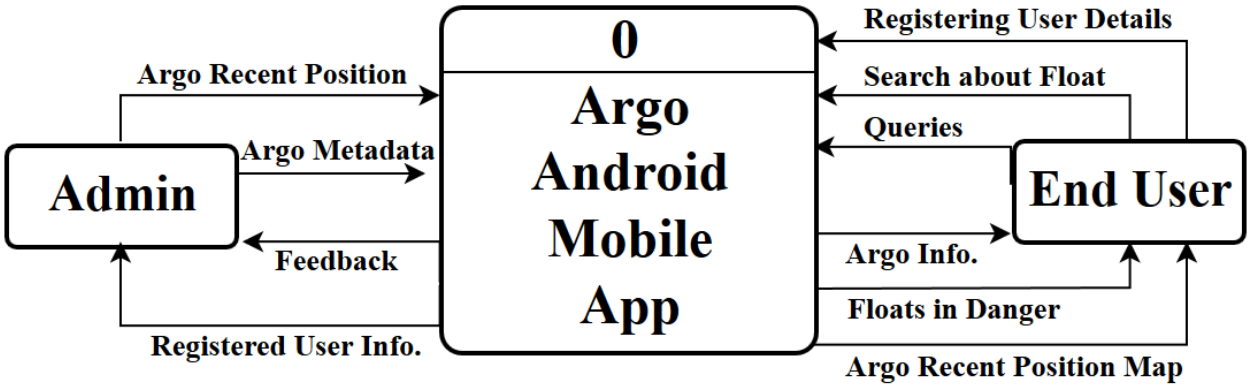

Figure 4: Context Diagram of Argo Android App.

From the above it is clear that the main actions performed by the admin user are the following:

i. Providing the metadata of newly deployed Argo floats in to the database of this application,

ii. Updating the recent positions of active Argo floats in to the database of this application,

iii. Receiving the feedback and suggestions on the app from the end users and improving it.
iv. Saving the details of the registered user (end user) information in the records for future.

The End user actions are more subjected to application usage, this user utilizes the Argo Android App as per his requirement. Before the user make use of the system, he has to install the app on his Android mobile and do first time login which is a small registering process and these information of end user goes to the admin user for the user records maintenance to know how many users are using this Argo Android App by registering on their mobile devices.

From the above figure it is easy to understand that the end user gets various services like,

i. Google Map displaying the positions of Argo floats as deployed by INCOIS,
ii. Google Map containing the current or most recent positions of active Argo floats,
iii. Google Map showing the recent positions floats in danger which need immediate attention,
iv. Bar Chart depicting the details of Argo floats deployed year-wise by INCOIS,
v. Search for information regarding metadata of any Argo float using some key terms,
vi. Sending feedback and suggestions or any other queries related to app to the admin.

2.2 System Architecture

The architecture of the Argo Android App is clearly shown in the Figure 5. This clearly explains the users about the usage and different modules present in the app. In this process firstly the app (.apk) file of Argo Android app has to be downloaded and installed on the Android mobile. During the first time visit of the app, it requests for one time registration and then a splash screen displayed for both the user i.e., first time user and the user who has already registered. The splash screen is an animation that portrays the working of the Argo float device inside the ocean. It is easy to understand from Fig 5 that there are six main blocks/modules in Argo Android App which provide major service activities to the end user. They are as follows:

1. **About Argo Float:** This module contains two sub modules such as Argo introduction and Argo animated videos. The first sub module i.e. Argo introduction gives insights about Argo floats and the second sub module i.e. Argo animated videos gives the links of YouTube videos that explains about the working of Argo floats and their usage.

2. **Argo Chart Zone:** This module is designed to provide the user with all the necessary statistical charts on Argo floats that are frequently required for the scientists working in the Argo program. It contains three major charts. They are given below:

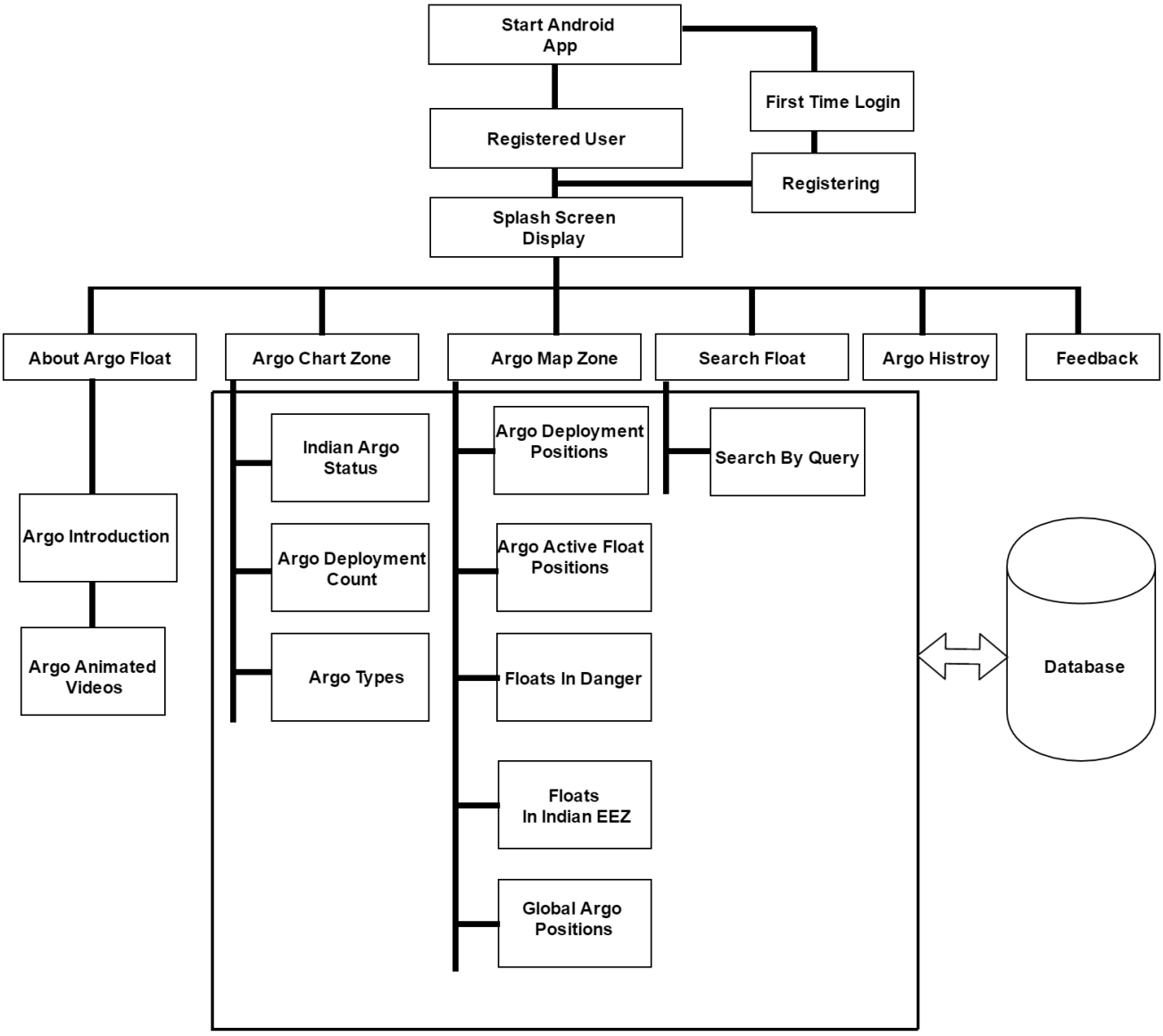

Figure 5: Architecture of Argo Android App

a.) Indian Argo Status Chart: This chart gives the current live and dead status of all the Indian Argo Float devices in the form of a pie-chart**.**

b.) Argo Deployment Count Chart: This chart shows a bar chart which provides all yearly deployment of Argo float devices since 2002 since when the Indian Argo Program started.

c.) Argo Type Count Chart: This shows very interesting information on the count of different types of Argo floats in the form of a bar chart format and at the same time this bar chart gives how many are live among the total deployed Argo floats in the Indian Ocean.

3. **Argo Map Zone:** This module is enormously filled with data that comprises of markers shown in various Google maps that represents the recent and deployed positions of Argo float devices. This module contains 5 different sub-module maps information which are as follows:

a.) Argo Deployment Positions Map: This map gives the deployed positions of Argo float in the form of markers shown on a Google Map deployed since 2002.

b.) Active Argo Float Positions Map: This Map gives all the recent or latest positions of the Argo float devices inside the ocean on a map. These floats are indicated as round markers and when clicked on them it reveals their information like WMOID, DEPLOYMENT DATE, LATITUDE and LONGITUDE. These markers are distinguished with different colors according to their types of floats.

c.) Floats in Danger Map: This map give the information and positions of all the Argo Float devices which are closer to ground/beach. When the floating device moves towards the beach or reach a point where bathymetry value may not be greater than 2500m is considered that particular device will hit the ground in its routine operation and this may cause damage to the float. Generally for most of the floats when a configuration is set before deployment, it remains locked throughout its life and cannot be changed or altered further. But there are few floats which are growing in number recently known as Iridium floats; they possess two way mode of communication by which their configuration can be changed. Thus using this app Iridium floats which are in danger of getting beached or grounded can be predetermined and hence these floats configuration can be changed accordingly to save them from getting damaged. Thus this app assists scientists to identify such floats and recover from huge loss to the field of research.

d.) Floats in Indian EEZ Map: This map provides all the information of the Argo Floats that are coming in the EEZ of Indian territory. EEZ is Economic Exclusive Zone of the country where much of the navy operations are carried out for the security of the country by the coast guards and Indian navy. Hence it is important to keep track of list of floats entering in EEZ.

e.) Global Argo Positions Map: This map gives the positions of all the active Argo floats globally deployed. It shows to the user the global density of Argo floats in all the five Oceans including Argo ice floats.

4. Search Float: This module help the users of Argo Android App to search the Argo float devices details by giving the WMO ID and it also provides the facility of listing all the WMO ID's of the Indian Argo Floats devices deployed by INCOIS. WMO ID is a unique id assigned to each and every Argo float globally by World Meteorological Organization before deployment. When WMO ID of Argo float is given for search, this app will provide the attributes of Argo float like deployed date, longitude, latitude, type of float, cruise ship which is used in deployment, current status of float whether it is alive or dead, telemetry number, parking depth, profiling depth, cycle period etc. This information can be used by the scientists and researchers for their own purpose of study.

5. Argo History: This module gives the result and planning of providing the history of Indian Argo Program since it started in the year 2002. Currently it contains the information of the First Argo Float deployed by Indian scientist with collaboration with country Canada. Is also gives the information like, "First Indian Ocean Argo implementation planning meeting was held on July 26-27, 2001 at Hyderabad.", etc.

6. Feedback: This module contains the methodology or process to send the feedback and suggestions from the end users to the app developers or the administrators for improving the app and providing additional features timely.

3. Results

The final result of the Argo Android App is a complete package for understanding and monitoring Indian Argo floats. This app provides total information about the metadata of Argo floats and current or most recent positions of Argo floats. All these services of this app can be availed after installing in Android device. In this process firstly the app (.apk) file of Argo Android app has to be downloaded and installed on the Android mobile. During the first time visit of the app, it requests for one time registration. Let us look at Figure 6 it shows the registration form of the app. This one time registration form will request the end users to enter their details like full name, email, occupation and company/university. After entering all the details and submitting, this

information will be sent to the administrator of the app and the registration is complete and successful. Now the end user can start availing the features and services of this app. This registration information submitted by the end user will reach the administrator via email. This information of end user is useful for the administrator for future study and analytics purpose.

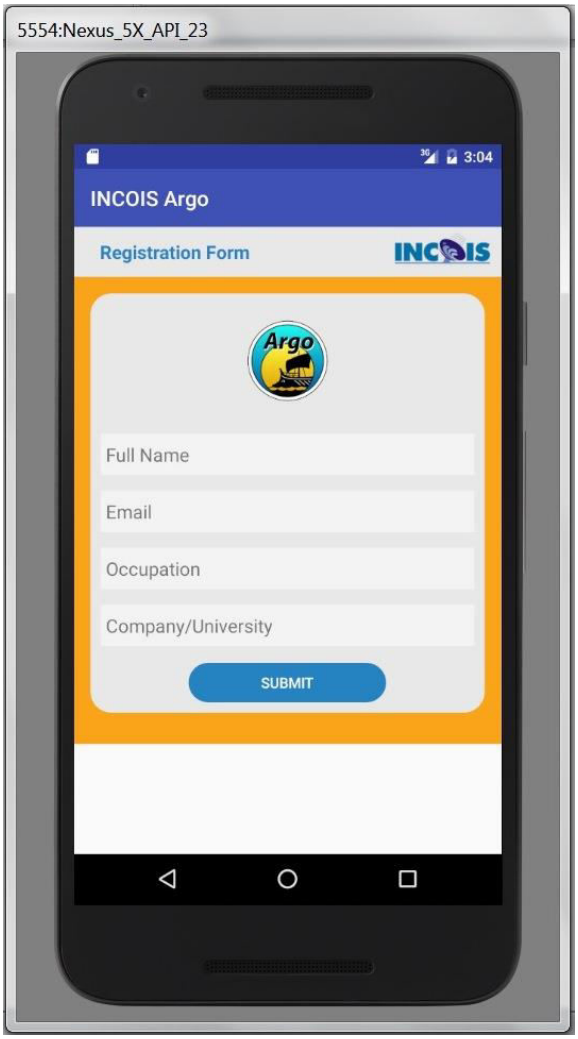

Figure 6: Registration Form of Argo Android App.

This app gives the information like charts where the users can see how many Argo floats active and inactive i.e. not working or dead, Figure 7 gives a clear pie chart showing the current status of Indian Argo program. This pie chart is generated using the Android library MPAndroidChart[10]. It is a powerful Android chart view/graph view library that provides scaling, dragging and animations. Thus this pie chart has features like rotatable option about its center and also zoomable

option on touching each slice. In this chart red color indicates the slice of dead floats among total floats deployed by INCOIS and green color indicates slice of active Indian Argo floats.

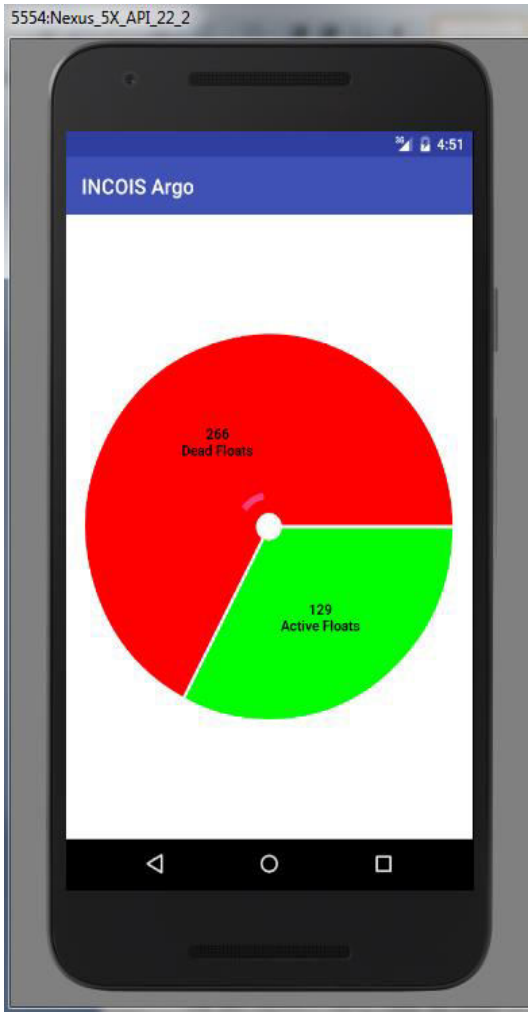

Figure 7: Pie Chart of Active and Dead Argo Floats.

Figure 8 is a bar chart, which explains about the deployment and usage of the Argo float instruments on yearly basis by INCOIS. The following bar chart explains how Indian Argo program is conducted since 2002. In this chart X-axis consists of year of deployment and Y-axis contains the number of Argo floats deployed in that year. The numerical present at top of each bar represent the exact number of Argo floats deployed in that year. Different colors are used in this bar chart indicate different number of Indian Argo floats deployed in each year by INCOIS. It clearly shows that India has deployed more than four hundred Argo floats in just fifteen years, is one of the significant achievements, which is faster than many other Argo deploying countries. From the below bar chart in Figure 8, it is evident that though Indian Argo program faced some

ups and downs initially slowly it got stabilized and in last five years it attained some consistency in deploying a good number of Argo floats. This bar chart is also generated using the Android library MPAndroidChart[10] library. This bar chart has all the main features like scaling, dragging and animations. This bar chart is also zoomable and scales change according to zoom level used by the end user according to his comfort and device used by the user.

Figure 8: Bar Chart of Yearly Deployed Argo floats since 2002.

There are various types of Argo floats deployed by INCOIS according to requirement for understanding the behavior of ocean. These floats are of different models and with various sensors for measuring temperature, salinity, dissolved oxygen, chlorophyll, FLBB, nitrates etc. Fig 9 shows different types of Indian Argo Floats deployed since 2002. The various types of floats like PROVOR-II, APEX-BIO, APEX 8C, APEX 9A, APEX 9G etc. In this chart X-axis shows the number of Argo floats deployed by INCOIS of that particular type and Y-axis shows the type of each Argo float. This bar chart has two colors red and green. The overall bar chart width projects the number of Argo floats deployed of that corresponding type. The width of red color bar indicates the number of dead floats and the width of green color bar indicates the number of active floats. For example consider a float type from the figure say APEX-9A which shows 60 are in total deployment list that is indicated in red color and less than 30 are active currently which is

indicated in green color. This bar chart is very interesting and is generated with the help of Android library MPAndroidChart[10] library. This bar chart covers all the main features like scaling, dragging and animations. When the user zooms in this bar chart the user can see the scale decreasing from 30 units to even less than that according to the amount of zoom level performed by the user.

Figure 9: Showing various Types of Argo Floats.

The next Figure 10 speaks about the searching Argo Float information with the help of WMO ID. When the WMO ID is given all the metadata information related to Argo float is displayed. In the same application screen a button named view all ids can be seen which displays list of all the deployed Argo float ids. After the end user enters the WMO ID, this activity works by communicating corresponding SQLite database and checks for the WMO ID entered by the user, if it is able to find the exact WMO ID matching in the database it will return the entire metadata to the user otherwise it will suggest the user saying that there is no match found for the entered WMO ID. The Figure 11 shows the display screen of end user when the WMO ID provided for the query is matching in the SQLite database. It is clear in this figure that the main metadata of Argo float like WMO ID, deployed date, deployed latitude and longitude, type of the float, Ship which is used to deploy the float, Cruise number of it, current status of float, telemetry type, parking depth,

profiling depth and cycle period of the float is displayed on the screen as per the request of end user. Here status of float can be either Alive or Dead. Telemetry type of the float which will be either IRIDIUM, which are two way communication floats or ARGOS, which are single way communication floats.

Figure 10: Search Float Information by its WMO ID.

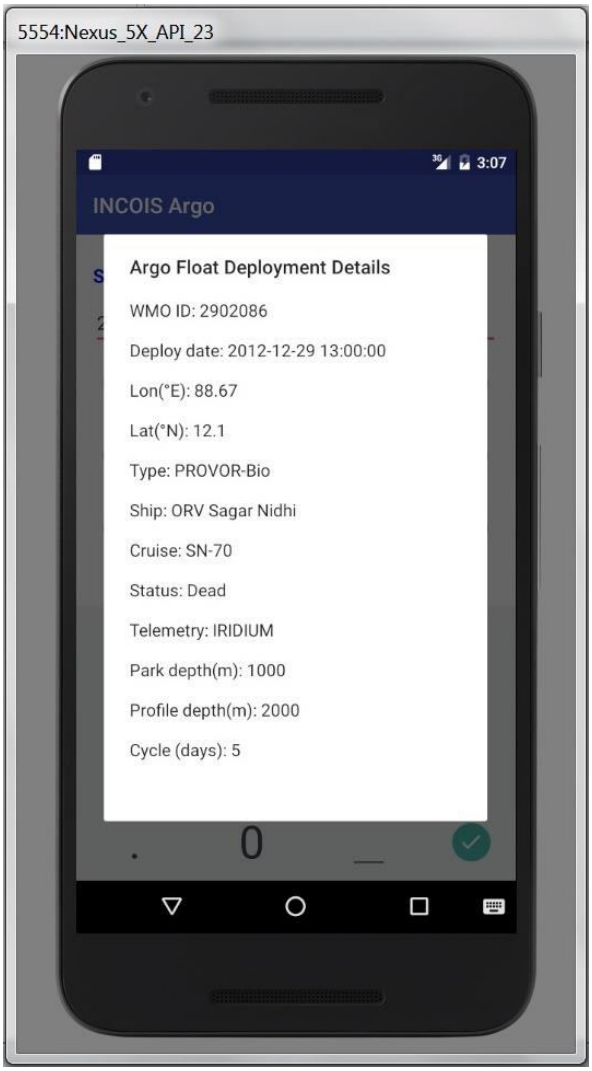

Figure 11: Argo Information displayed after search.

This Android application also has map section where all the Argo Floats position can be seen in a Google map. The informative maps are many but three are must to be spoken about and user has to know about them and use it.

(a) Deployment Map for Argo Floats: This map gives the deployed positions of the Argo float in Indian Ocean i.e. initially where the Argo float has been first placed from ship in the ocean. This

map help the scientist to deploy the Argo float in new area to reach unreached areas, Figure 12 shows all the Indian Argo floats according to their deployed positions.

(b) Current Positions Map for Argo Floats: Usually after the Argo float is deployed, they start drifting with currents and for every 10 days cycle or its actual cycle period they reach the surface and communicate its position through GPS satellites. Tracking the current location also becomes very important to make use of the Argo Float data in research. For this change in Argo float position has to be recorded. This map i.e. Figure 13 displays the current or most recent location given by the Argo float in its last cycle.

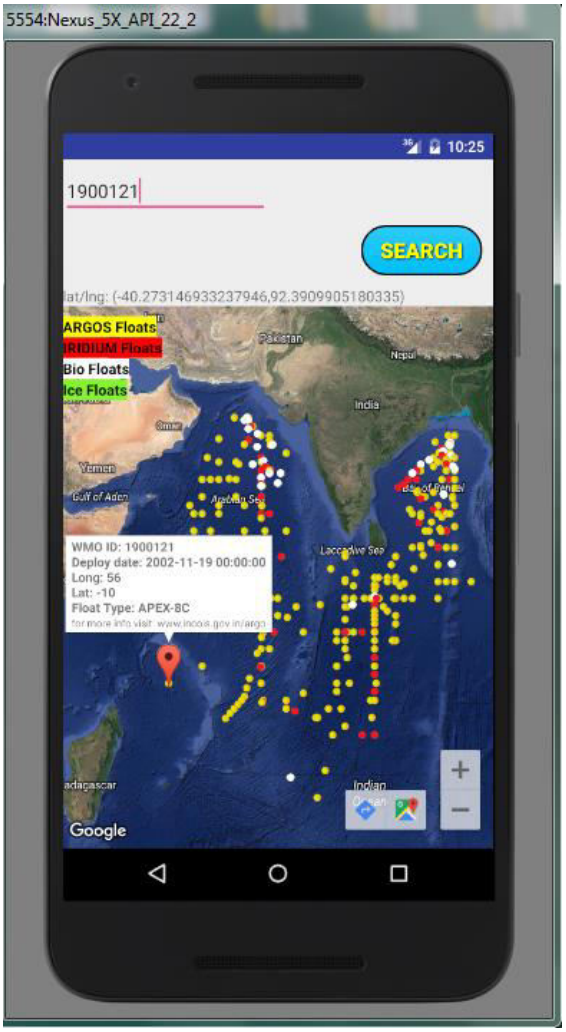

Figure 12: Map View for deployed All Argo Floats.

Figure 13: Map View for Indian Working Argo Floats.

(c) Argo Floats in danger: The following Figure 14 is showing three Argo Floats, which are either beaching or grounding. Beaching means they are drifting towards land. When these Argo floats

keep moving close to land then the depth of the water become lesser and lesser, but Argo floats has to go 2000m down the ocean from ocean surface. So near to the land the depth will be less than 2000m. So here in this case the ocean depth of 2500m has taken as danger depth for Argo floats and when the float go closer to 2500m depth or less then that float will be taken as either beaching float or grounding float. These types of floats may not act normally and there will always be the chances of losing the instrument or malfunction of the Argo float. These types of Argo Floats have been shown in the Figure 14 for the current period.

Figure 14: Map View for Argo Floats beaching/in danger.

The following figure i.e. Figure 15 shows the map of global Argo network which gives the positions of all the active Argo floats globally deployed in all the Oceans. It shows to the user the

global density of Argo floats in all the five Oceans including Argo ice floats. This map helps the scientists to identify the region with high, medium and low (density) availability of Argo float devices in different regions and plan for the next deployment of new Argo floats. This map also shows how the target of achieving at least one float in every two degree latitude and two degree longitude is clearly overcome by global Argo program.

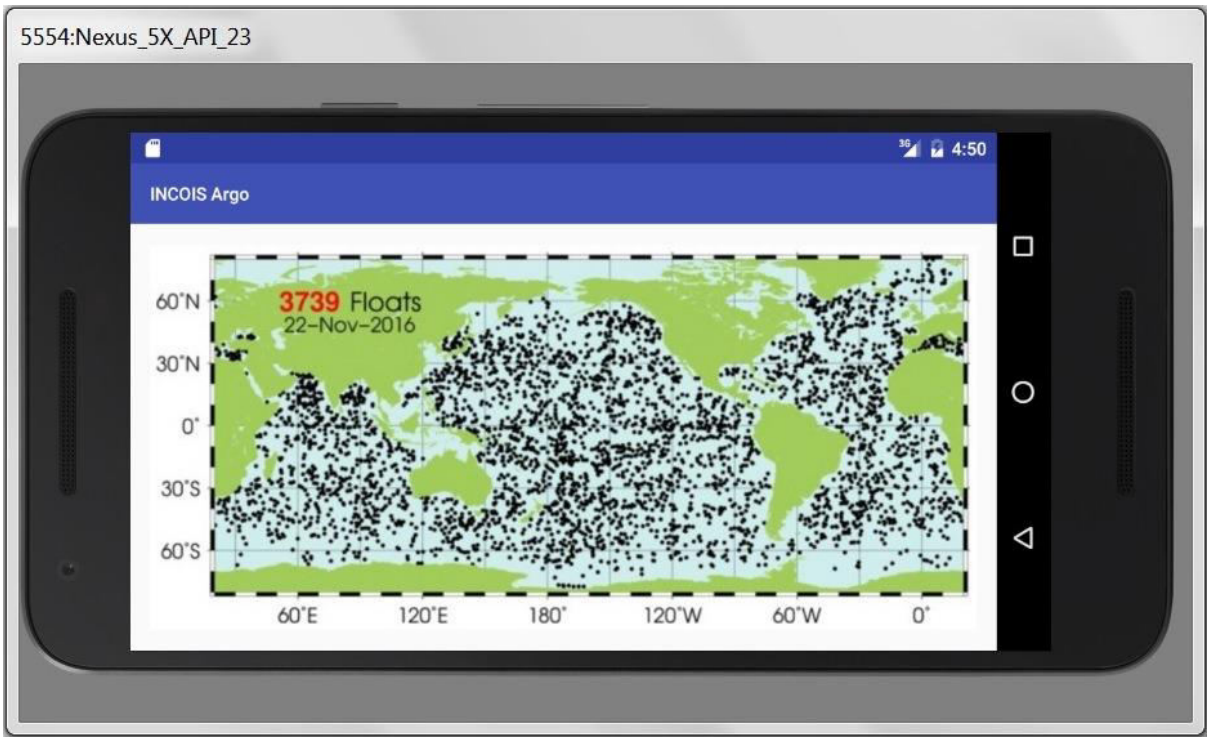

Figure 15: Status of Global Argo floats.

4. Conclusions and Future Work

This Android app is extremely informative to the scientists who are working in the area of Meteorology, Oceanography, Geology, etc. It provides all the information related to Indian Argo program. The real-time aspect of Indian Argo float is the main strength of this app. Today we see a large bulk of information about Argo on internet but that is spread all over and searching it in a web browser is very tedious task. This Android app is a complete package in itself which is greatly portable and unique. It is an effective app that can be installed on the Android supported mobile and information of Argo float can be viewed clearly by the end user whenever and wherever he wants with the help of mobile internet. This app provides the instrument locations bases

information in the form of Google maps, which can be easily understood by any user. This app is mainly useful to scientists who want to understand the behavior of the Oceans.

Maintaining a perfect resolution so that it will match mobiles of different sizes which are using Android OS was a challenging task in designing and developing this app. This app is currently for Argo float instrument but in future many other instruments can be included from which the community of scientists can benefit more and more in not only understanding the oceans but predicting the climatic changes accurately. This app can also be designed in such a way that it can support other mobiles with Windows, IOS or any other mobile operating system as currently it is a native app supported only on Android based mobiles.

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