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Effective Localization Depending on Indoor or Outdoor Context

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Abstract: **- Today, there is the broad utilization of mobile applications that exploit a user's location. Prominent uses of a location data incorporate geotagging via web-based networking media sites, driver help and route, and questioning adjacent areas of intrigue. Although, the normal client may not understand the high energy expenses of utilizing location services (to be specific the GPS) or may not settle on smart choices in the matter of when to endow or deny the location services—for instance, when indoors. As a result, a system that can make these choices for the user's sake can essentially enhance a cell phone's battery life. In this paper, we exhibit an energy dissipation inspection of the localization methods on present day Android cell phones and propose the indoor localization system that can be activated relying upon whether a user is recognized to be indoors or outdoors. With respect to our analysis and execution of our proposed system, we give exploratory outcomes—observing battery life after some time—and demonstrate that an indoor localization strategy activated by indoor or outdoor setting can enhance cell phone battery life and, possibly, location exactness.**

Keywords**: Context-aware services, energy efficiency, Internet of things, mobile computing, operating systems, sensor systems and applications.**

I. INTRODUCTION

Location based applications on current smart phones have acknowledged across the board use in the present society—to the point where it can even be said that numerous have moved toward becoming dependent on these kinds of applications. Location data is utilized to geotag posts via social media sites, to convey the nearby climate and news, to enable users to explore to a desired location, and to furnish information on close-by restaurants and stores. In any case, users frequently need to adjust the comfort furthermore, usefulness of these location-based applications with a cell phone's battery life. The current smartphones offer two major forms of finding a user's location the first is GPS and latter is a network- based method that uses features like Wi-Fi and cellular radio. The tradeoff between these two descends to accuracy versus energy. Applications that require location data choose to use power craving GPS while applications with more coarse prerequisites may utilize the network-based provider, which is less exact but has greater energy efficiency. The user can frequently switch the location services on or off and, with Android phones, can also enable or disable above two methods to improve phone's energy and accuracy. On the other side, developers of location-based applications can lower the energy utilization depending on application requirements or another context. Although, developers cannot always predict when to dynamically toggle the methods. But the location information returned by network-based method will not be accurate in some applications for this case, the GPS will always be requested despite of environment or context. This leads to an energy dissipation where the GPS is inaccessible or inaccurate in indoors. Hence a system that can make choices in regards to location services based on context and also influence all installed location-based applications will results in notable energy savings. We provide an analysis of two localization methods available to current smartphones and concluded that addition of indoor localization method and in addition that ability to distinguish indoor or outdoor can enhance battery life and location exactness. To test this, we perform an indoor/outdoor detection service and a localization method into Android location services framework of android operating system. In our design, we execute an indoor/ outdoor detection altered from another author's past work and actualize Wi-Fi RSS ranging indoor localization method. Practically speaking any such indoor localization strategy used to derive the user's location and future work can center around this perspective to increase location accuracy. we contribute the following things to the proposed system. To Provide an energy dissipation investigation between Android's past localization strategies (GPS and network-based) and our proposed solution we implement an existing indoor/outdoor detection framework in the Android operating system. We develop the Android application service in the which the indoor localization strategy can be implemented to infer user's location in a quick and effective way by modifying the FusedLocation Provider API to powerfully switch between the GPS and an indoor based location provider relying upon indoor/outdoor context.

This paper is arranged as follows. Section II reviews related work on context sensing, energy-efficient location sensing, indoor localization. Section III provides background information on Android's location framework. Section IV provides our energy dissipation analysis of Android's existing localization technique in our proposed approach. Section V discusses our experimental outcomes. Section VI presents future research directions and provides conclusion.

II. RELEVANT WORK

Our solution spans four primary regions: environmental context, energy-efficient location detection, indoor localization. Gathering information about the user's action or the environment has variety of applications as a trigger for energy-efficient mechanisms [1]. Enhancing energy effectiveness of smartphones will continuously be a progressing research region. Furthermore, the high energy cost of using location services make it an impressive area for energy-efficient enhancements. Research on mobile devices occur at the application level, as in creating energy-efficient applications. Zhou et al. [2] proposed indoor/outdoor detection service. In their work detection is classified into "indoor," semi-outdoor," and "outdoor" and is determined by using the combination of magnetometer, accelerometer, and proximity sensors. Our experimental outcomes expand the idea of implementing the application as a service in Android operating system and indoor/outdoor context as a switch for indoor localization.

Other past work on external context includes detecting user movement or environmental context. Using a smartphone's sensors to surmise a user's walking direction has been reviewed in numerous past works, most using the accelerometer or related inertial movement sensors. Roy et al.[3] proposed the recent illustration. The patterns of motion that occur during walking such as armsway and bounce are considered. Nath [4] exhibited ACE, a middleware that meant to induce a user's activities and the environment. It aimed to detect the coarse-grained user exercises including running, driving, or being in the work environment. drive with the goal of distinguishing hazardous driving practices. Energy-efficient location is a well-known smartphone research region. Zhang et al. [5] proposed SensTrack, a framework that utilize a smartphone's sensors to determine when location services need to be invoked was proposed by Zhang et al [5]. Their framework moreover powerfully changed to a network-based location provider at the point when GPS signals are not accessible and Wi-Fi is associated. The Android operating system is open-source and freely modifiable, allowing researchers to execute experiments into the OS. This permits research in the region of smartphone's performance, privacy, as well as energy efficiency. Our proposed solution focuses on Android service that uses indoor and outdoor context as a switch for energy effective localization methods which runs in a background same as other Android applications.

III.BACKGROUND

Our experimental solution and analysis of Android's localization methods describes the unmodified location services framework within the Android operating system. After that we customize the indoor/outdoor detection system from a past work [2], which we adapt into our solution. The reason for this implementation is to provide the smart decision on behalf of selecting the appropriate location provider with respect to the indoor-outdoor detection. The following sub sections depicts the exact background working and the components that are to be considered, modules, functions, classes from the Android services for the implementation.

A. Android Location Services Framework

Usually, Android application developers could request location information from the OS by specifying a location provider and mentioning timing and distance requirements. The following fig.1 illustrates internal portrayal of this procedure. LocationManager instances get location requests from applications and forward them to related LocationManagerService. It handles requests and communicate with the system's location providers. Instead of using the explicitly named location provider developers use Fused- LocationProvider API as part of Google Play Services which is installed on Android devices and also network provider determines a user's location by request to Google's Servers. The FusedLocationProvider API receives the accuracy and power requirements from the applications and it returns most suitable location provider to use. By utilizing the API user can improve location accuracy and energy consumption. The following fig. 2 illustrates the process of making location request using the fused provider.

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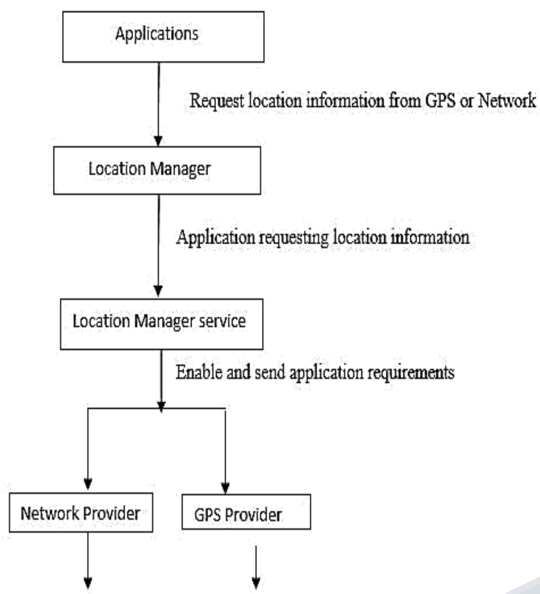

Fig 1 Diagrammatic view of explicitly specifying location provider

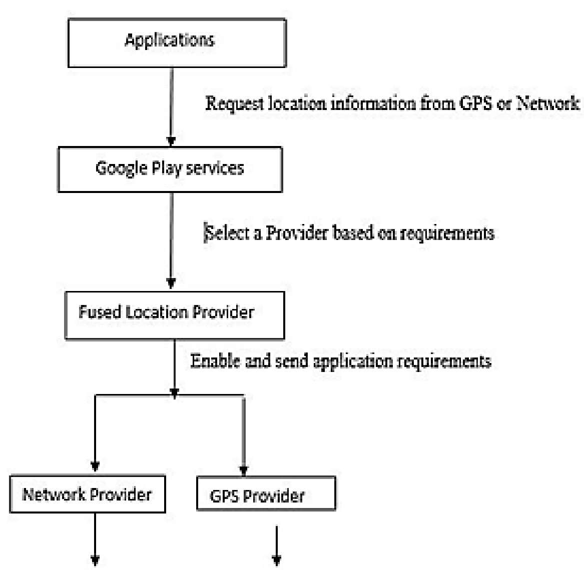

Fig 2 Diagrammatic view of requesting Fused provider

B. Indoor or Outdoor Detection Service

The design of our solution includes the usage of indoor/outdoor service as a genuine service in the Android Operating system. We picked their framework for an assortment of reasons. At last the system was developed for Android devices and sensors which are generally accessible in android smartphones. Consequently, to the best of our insight it was the best framework to use in our design.

The Indoor-outdoor detection falls in one of the following three states:

1) Indoors – Located inside the building or any closed area.

2) Outdoors-- Sensed outside the building or any open environment.

3) Semi-Outdoor—Sensed in between the open and closed environment for eg: Balcony.

The following are the components used to detect smartphone's status:

1) Accelerometer -- step detection to trigger the indoor/outdoor identification.

2) Cellular radio – Fluctuations of adjacent cell tower's RSS over time.

3) Magnetometer – measures variance in the local magnetic field.

4) Light sensor – measures location brightness; identification based on time of the day.

5) Proximity sensor – phone in pocket detection; used to approve light sensor readings. Based on user's movement the gathered data are accumulated to update the indoor-outdoor status. The properties of their calculation enable it to be actualized as a service without affecting the location accuracy.

IV. PROPOSED SYSTEM

The proposed system section describes our development platform and our implementation of service in the Android operating system for our experiment. It involves the indoor/outdoor service implementation, a new indoor based location provider and a modification to the Fused location provider API into consideration.

A. Development Platform

We implement our experimental solution by integrating the Android Open Source Project (AOSP) – Android Version. We directly modifying the open-source Fused Location Package integrated with the AOSP which selects proper location data based on power and accuracy requirements. Our solution is being tested on the ONE PLUS 5T smartphone which contains a 4*2.4 octa core processor, 6 GB of RAM, a 3300 mAh battery and all the sensors required by the indoor/outdoor detection. Network requests made over Wi-Fi but the phone is on a cellular plan with mobile data.

B. Android Application Service

The major process of our experiment is the implementation of indoor localization method as a service into the OS to sense locations in an effective way which enhances the efficiency in energy and accuracy in location. Initially, we adapt the solution from [2] as a system service in the Android operating system using source code supplied from the authors. Our implementation utilizes a "manager" class to act as intermediary between applications and actual service. As a result, our design for the service mirrors standard structure of Android System services which leads the application developers to access indoor/outdoor context. A new location provider called inferred Location provider to infer user's location while indoors. We have a Wi-Fi RSS ranging method which provides RSS values using Android APIs. It can be obtained via WI-Fi scans automatically occurs a few times per minute. It also be manually requested.

Our implementation of new location provider request location as same as other providers. In fact, Fused Location provider API modifications it records context updates from the indoor/ outdoor detection service If it is detected to be indoors fused switch to new(inferred) location provider and it should be able to switch back if it sensed as outdoors. Moreover, the detection service does not work until it will be invoked by FusedLocation provider. Because of this plan applications which depends on FusedLocation provider API will be influenced. As we expect that this solution would greatly reduce energy dissipation. Simply, our modifications to Fused APIs for selecting the appropriate location providers with respect to user's detection strategy whether indoors or outdoors to improve location exactness and lower the energy dissipation. Fig 3 shows the systematic implementation of location framework where fused location provider invokes the indoor-outdoor detection to update the status and choose the appropriate location provider

V EXPERIMENTAL RESULTS

The methodology is tested in Android smartphone ONE PLUS 5T model version 6.0 integrated with Android Open Source Project. The aggregated detector contains the light magnetic and proximity sensors which are actually present in the system by default. The proposed work was grouped to detect user's context and based on the context suggesting the user to use appropriate location provider to save energy dissipation.

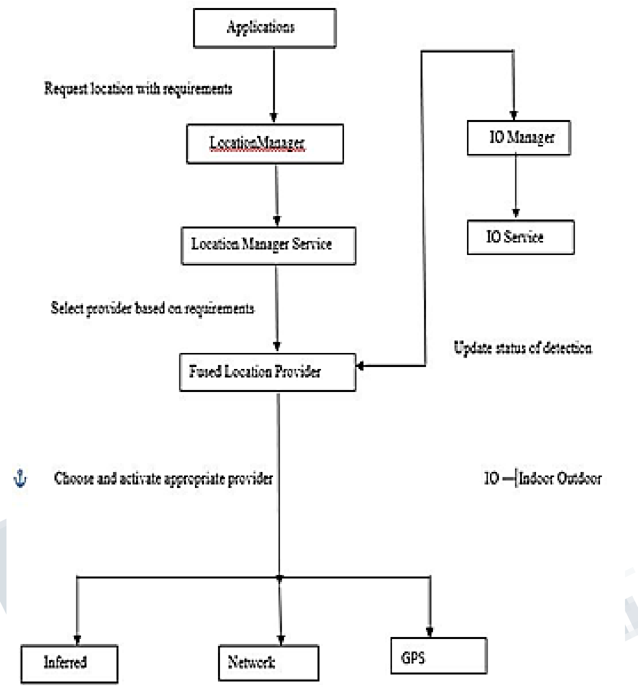

Fig 3. Systematic Implementation of Location framework

Sensors and its values that are used to detect indoor outdoor context are gathered and from each and every sensor the confidence values are calculated and it is described in detail in [2]. Fig 4 shows the different sensors such as light, magnetic, proximity and RSS values which returns their appropriate confidence level values with the context that sensed. Light and Magnetic sensors are used to find the lux and gauss values to detect the context. The proximity sensors are used to find the user's action and to update the detection system about the user's movements. The maximum confidence level and maximum occurrence of the context are taken into consideration. The battery percentage shows the efficiency over selecting the location provider to use. The hardware component usage must be determined to find out the battery usage as reported to the Android's battery service. To estimate the battery life for an indoor localization method, RSS readings are gathered and for location providers the hardware usage are considered in the case of GPS and sensors which drew current when in use. For Network provider it makes Wi-Fi scans for every 20s to update the location. To calculate the battery life values for the current drawn by each of the hardware are considered. This results the number of hours that the battery will last. We calculate the average current drawn per minute with the equation:

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$$\sum_{i=0}^{n} \frac{ti*pi}{60}$$

Where i- hardware component, t- time in seconds component used, p- current draw per minute.

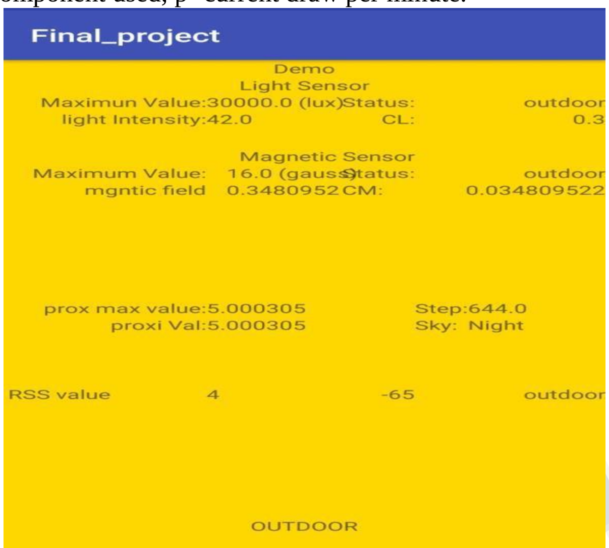

Fig 4: Confidence Level of sensors and the IO detection Context

In the above figure the light, magnetic, proximity and RSS values gives the status as outdoor. Hence the resultant detected context sensed as outdoor. The context status can be different for the different sensors and RSS. But the resultant context can be produced by taking the cumulative status of the context given by the sensors and RSS readings. The Fig 4 shows that the outdoor is sensed by the all sensors and RSS. But in the Fig 4.1 depicts that the different context is sensed by the light, magnetic sensors and RSS. Fig 4.2 describes that even light and magnetic sensors provides different context. Hence we consider the aggregated context.

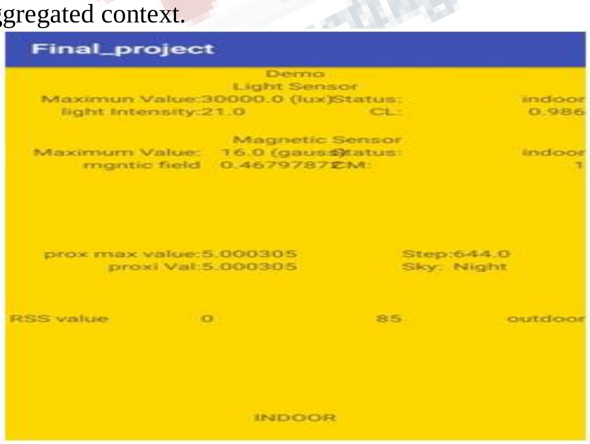

Fig 4.1 Confidence Level of sensors and RSS values differs

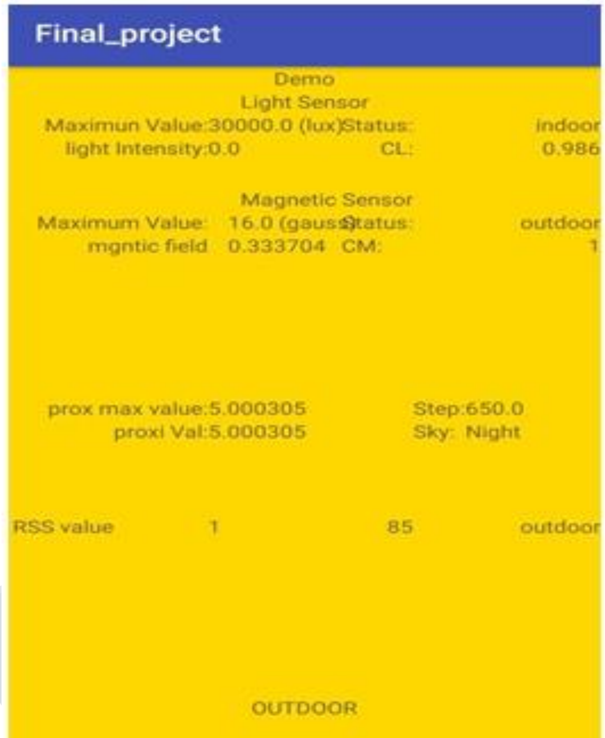

Fig 4.2 Confidence level and context of sensors differs

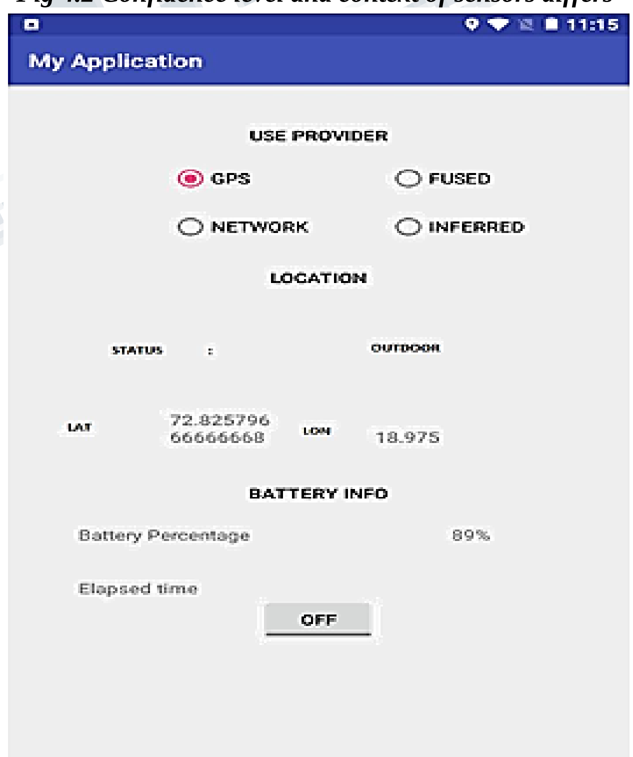

Fig 5Testing application

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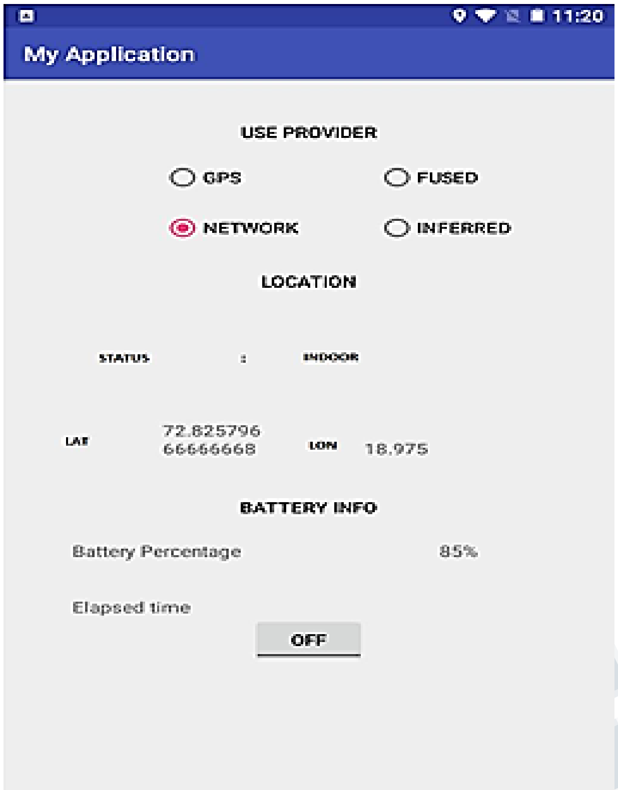

Fig 5.1 Testing application when using network provider

If the energy efficiency can be improved it also enhance the fused provider to work in a effective way. In our tests we found that indoor outdoor detection exactness to be about 75% although we used different devices and are in a different environments. However it would not be feasible because of the dense deployment of wireless access points. The fig 5 depicts the exact design of application which includes the battery condition and draining percentage level with respect to the location provider used. Fig 5.1 displays the latitude and longitude when the network location provider used. To run the experiment , the smartphone charged to 100% of battery life. At the same time localization methods are ready to return the locations as soon as possible. The testing application will now provide the exact location provider that consumes less energy depending on the indoor outdoor context by showing the battery consumption. Moreover performance is naturally proportional to the battery dissipation. Lower performance relies greater CPU usage results less energy efficiency. Usually GPS is considered for its energy consumption not for performance however our service would not affect the usability of the device.

VI. CONCLUSION AND FUTURE WORK

Future work focus on enhancing the accuracy and energy efficiency in effective manner. In this design detection lowers the efficacy of the FusedLocation provider. We center around the accuracy over Wi-Fi based metrics and to explore new sensors integrated into smartphones. Also focusing on privacy and control over the location information is possible quenching area. This paper can be proposed to make the smart decisions over which localization method to use on behalf of the user. Our outcomes displys that the detection system works in a effective way and localization method drain less energy and accurate in indoor environments. Future work is based on the improvement of accuracy over the location on smartphone environment.

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