Energy Efficient Location Tracking For Android Smartphones

Bade Ankamma Rao[1], Shaik.Ruhisha[2]
[1]ASSISTANT PROFESSOR, Dept of MCA
[2]Dept of MCA
[1, 2] St. Mary's Group Of Institutions, Guntur, Andhra Pradesh, India

Abstract- *The invention of Global Positioning System(GPS) makes outdoor navigation possible with greater accuracy. The GPS achieves high accuracy but, the average user may not realize the high energy costs of using location services (namely the GPS) or users do not know when to enable or disable location services.In indoor the GPS will be inaccurate. So we need a efficient and reliable technique to find the indoor location. In this paper we develop an android based application which enables to find the location of the smartphone in indoor environment and propose indoor localization mechanism that can be triggered depending on whether the user is in indoor or outdoor environment. As a result a mechanism that take decision on user's behalf will improve battery life. So a smartphone having magnetic field sensor and accelerometer sensor allows the application to provide the indoor navigation facility to the end user.*

Keywords- Indoor Navigation, Energy efficiency, Indoor positioning.

I. INTRODUCTION

In modern android smart phones location based applications are widely used in today's society. These location information is used to deliver the local weather, will help users to navigate to desired location, used to find nearby places. However the users have to balance the functionality of location services with the smart phone's battery life. The current available system make use of GPS and network based method for finding the location. The GPS offers efficient and accurate navigation system in outdoor environment and the network based method uses cellular radio(RSS) and WIFI. In these two methods tradeoff occurs between accuracy verses energy. Applications that require accurate location information will use power hungry GPS where as applications that require coarse locations will use network based method. In this network based method the location returned will be less accurate but the energy consumed will be less. In indoor the location returned by GPS will be inaccurate and this leads to wastage of energy resources. We can use Bluetooth for indoor navigation but it has only limited range and also we need to setup Bluetooth hotspot across the building. Here the implementation and maintenance cost is vey high. In this work we put forward a simple, reliable and efficient method by sensing the magnetic field at various location across the building. For this we need the smart phone with built in sensors like magnetometer, gyroscope and accelerometer. The magnetic positioning is the sufficient technique for tracking users in indoor environment. Pillars and electrical equipment inside the building affects the earth magnetic field, so its intensity at different locations will be unique. So if the magnetic field map of the indoor area is available, then the indoor location of the user can be tracked by comparing the magnetic features of his current location with the map.

Our contribution are as follows:

- Implement an Indoor/Outdoor detection system.
- Create a new location provider to infer the user's location in energy efficient manner.
- Making changes to the fusedlocationprovider API to dynamically switch between GPS and indoor localization based on the indoor/outdoor context.

We have organized the paper in the following ways. The Section II provides the summary of the previous works, Section III describes the describes the background theory and Section IV describes the methodologies and V describes implementation results and followed by conclusion and future work.

Nicholas Capurso [1]proposed a mechanism for tracking the location of the user based on indoor/outdoor context in an energy efficient manner. Improving the energy efficiency of the android smartphone will always be an research idea. Our solution spans the following ideas 1) energy efficient location sensing; 2) indoor localization; 3) environmental context. But above all those technologies using the magnetic field signals generated in the indoor spaces is more reliable and efficient. Zhou et al. [2] proposed indoor/outdoor detection service and is determined by using cellular tower RSS and the light sensor. Zhang et al. [3]

proposed a technique called senstrack, a system that uses smart phones sensor to determine when the location services need to be invoked. Their system also changes to network based methods when GPS is not available and connected to wifi.and Xueyang Wang [4] proposed a new method which is based on dead reckoning algorithm for efficient indoor location. JanneHaverinen[5] proposed a new technique known as self localization technique which has few improvement on Monte Carlo Localization (MCL) technique. The measurement setup for human self-localization is done by a 3-axis magnetometer which is kept on the person's chest.The magnetometer sensor measures the magnetic reading and send the data to the base station wirelessly.The uses of magnetometer sensor and magnetic field for localization can also be seen in [6].

II. BACKGROUND THEORY

A. MAGNETOMETER

The magnetometer sensor inside the smartphone is capable of sensing a magnetic field of earth and determines the direction.When it is turned on the navigation can be done in better way.

B. GYROSCOPE

The smart phones are equipped with gyroscope sensor for navigation purpose and for measuring the angular velocity in the x, y, and z directions. Without gyroscope sensor the smart phones will have disadvantages such as

- Impossible to play motion games.
- The orientations of the device may not be possible.
- Images in the phone can boot be seen in tilted Position.

C. DEFAULT LOCATION FRAMWORK

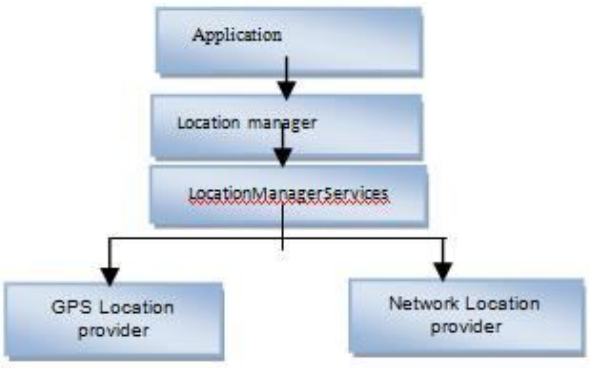

Fig1: Explicitly specifying a location provider

We describe the android's unmodified location services framework present in the android operating system. Normally the application developers request the location information from the operating system by explicitly specifying the location provider.

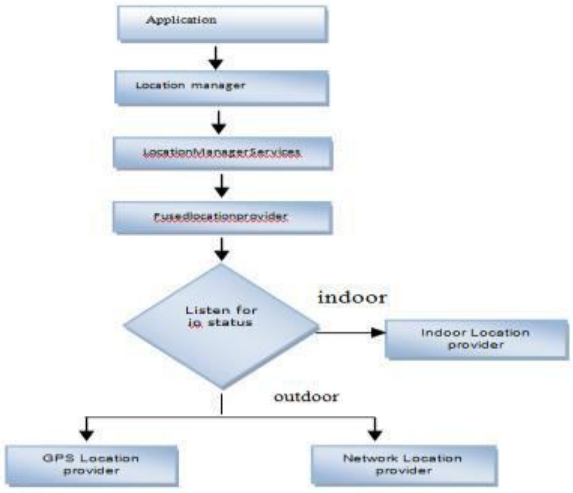

Fig2: system design

The figure2 explains the proposed system the user request the location information through the application. The request is then forwarded to the location manager. The location manager intends send the request to ,The location services and then to the fused location provider. This API checks whether the phone is in indoor or outdoor environment using IODETECTOR. If the Smartphone is in indoor environment then the location is returned using indoor location provider or if the phone is detected to be in outdoor the location is returned using either GPS or network provider.

III. METHODOLOGIES

A. Indoor/outdoor Location detection

IO Detector leverages primarily light weight sensing resources including light sensors, magnetism sensors, cell tower signals, etc. . . .The location context is classified in to three for detecting the location context they ar "indoor","semi-indoor" and "outdoor".

To determine whether the Smartphone is indoor/outdoor environment we use the following component.

1. Cellular radio-variance of nearby cell tower Radio Signal Strength over time.
2. Light sensor—It measures environmental Brightness, detection based on time-of-day.

3. Proximity sensor—phone-in-pocket detection; used to validate light sensor readings.

The light sensor is used to capture ambition light signals to determine the surrounding environment. The RSS (Radio Signal Strength) from a cell tower by a mobile phone changes dramatically from the outdoor to indoor environment. The collected data is aggregated to update the indoor/outdoor status depending on user's mobility.

B. Fused location provider API

Depending on indoor/outdoor status the Fused Location provider API will dynamically switch between the GPS and an indoor based location provider. Thus the traditional method of explicitly naming a location provider, (such as turn on GPS or turn on network location provider) is not carried since; this API will dynamically turn on the appropriate provider. So by this energy consumed or wasted will also be reduced. The different priority in fused location provider API is High Accuracy, Balanced Power, No power.

Our main aim is to reduce the energy consumption so we use "balance power". Here the accuracy will be around 10-20 stand energy consumed will be high when comparing with the traditional method.

Environment	Outdoor	Semi-indoor	Indoor
Definition	Outside a building	Near a building	Inside a building
Examples			
Secnes			

Fig3: Representation of indoor and outdoor environment.

In our modification if the Smartphone is detected to be indoors, the fused location provider will switch the current location provider request to the indoor location provider. This modification will help users for choosing between location providers on behalf of user's thus reducing the battery usage.

C. Indoor Location Provider

To read the earth's magnetic field every smart phone is built with magnetometer sensor. so, as a result the device can identify the direction and can rotate the screen based on physical orientation. The magnetic field values of different indoor environment are not same and changes in particular moment. Here step length and orientation are measured using the magnetometer and the gyroscope thus correspondingly the location of the user can be tracked.

IV. EVALUATION PARAMETERS

To analyze the battery withstand time we need to Find the average current draw. For this we need to know the battery capacity of our device (2300MAH) and divide the battery capacity with the current drawn by each test on the hardware.

We estimate the average current draw per minute with the Following equation:

$$= \frac{\sum_{x=1} R_x * P^{n}}{60} \qquad (1)$$

Here x represent the hardware component, R represent the component used for how many seconds/minute and P represent the current draw for the component. for eg: when performing network location provider test the following components are involved {wifi.scan, wifi.active, wifi.on, cpu.active, screen.full}with following current draw p{ 75.48, 73.24, 3.5, 57.9, 221.90}and t {3, 3,60, 60, 60}.The result will be after applying the above equation(1) is 290.736 and on dividing our battery capacity by this yields 7.223 estimated hrs of battery life. Some components and their average current draw is listed below

Table 1: power draw of relevant hardware component.

Component	Draw (MA)	Hours of battery
Wifi.on	3.5	Wifi.on, transmitting, scanning
Wifi.scan	75.48	Wifi-scanning
Wifi.active	73.24	Wifi-transmtting,or receiving
Cpu.active	57.9	Cpu draw at low frequency
Cpu.idle	17.4	Cpu draw but not active
accelerometer	0.45	Accelerometer sensor
magnetometer	5.0	Magnetometer sensor
Light sensor	12.675	Light sensor

These data are collected from powerprofile.xml file provided by the manufacturer of the smartphone. This file holds the data of different hardware component and their current draw information that are shown in the above table.

V. RESULT & DISCUSSION

The result of our experiment shows that the indoor location provider uses less energy when comparing with GPS found by calculating battery withstand time. It is found that when using indoor location provider the battery withstand time is 9.84 hrs while when using GPS the battery withstand time is 8.67 hrs. These results are calculated by using (1).It shows that the amount of energy consumed by GPS is high when compared with indoor location provider.

Fig 4: shows the indoor location of smartphone inside a building.

Fig 5: For pictorial representation it is shown by using Google maps and we placed a marker on the exact user Location inside a building.

Fig 6: comparing indoor and GPS with battery with stand time.

VI. CONCLUSION & FUTUTRE WORK

In this paper a new design is proposed and implemented to increase the energy efficiency of an android smart phones thus increasing the battery withstand time of the android smartphones. Thus the users does not need to balance the functionality when using network services.

The IODETECTOR is not accurate as expected so the future work can focus on improving the indoor and outdoor detection.This detection technique will have large affect in energy consumption[8] so the future work can focus on improving the detection.

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