

ENERGY EFFICIENT TRACKING SMARTPHONE USERS USING ACTIVITY RECOGNITION & LOCATION-BASED SERVICES

Abhishek¹ | SakshiGotiwadkar² | Vishal Sambyal³ | Yuvraj N.N⁴

¹(Computer, SPPU, Pune, India, abby160292@gmail.com)

²(Computer, SPPU, Pune, India, sakshipg22@gmail.com)

³(Computer, SPPU, Pune, India, vishalrealsambyal@gmail.com)

⁴(Computer, SPPU, Pune, India, yuvacse789@gmail.com)

Abstract— The number of Smartphone users has increased tremendously over these past few years. Tracking a device through Smartphone comes with various sensor set which consumes a lot of power and continuous use of GPS drains the battery in few hours'.GPS capabilities in indoor conditions is not accurate. Alternative use of LBS can made for indoor locations. As battery life is main factor in such scenario which must be considered. This work proposed the combined approach of GPS, Activity recognition, Cellular tower triangulation and WI-FI for energy efficient tracking of Smartphone.

Keywords—GPS; Cellular Tower Triangulation; Mobile Sensors

1. INTRODUCTION

Nowadays humans are dependent on their Smartphone for their daily needs such as e-shopping, e-banking, etc. results in the importance of user's locations for organizations to expand their business.

Successful use of LBS on mobile devices, shouldn't consume more energy. Power requirement features in mobile device are increasing but development in the field of phone's battery capacity is not much impressive. Use of such LBS techniques reduces the performance of battery consumption. Popularity of LBS has two major aspects. First, it relies on device's geographical location. Secondly, its ability to locate its current location.

Localization technology mostly based on Global Positioning System (GPS), various technologies obtain location assistance from Wi-Fi and cellular tower triangulation, each of which varies in energy consumption and accuracy. Accuracy obtained by GPS is more as compared to Wi-Fi and cellular tower. GPS is preferred mostly, even though GPS has more energy consumption. However, developing less power consuming LBS is not an easy task, since these uses features that requires more power for example-display of maps, use of radio and use of built-in GPS receiver. Development of such applications must be done to reduce power consumption using such features, when such services run regularly and continuously.

2. RELATED WORK

To track the user's location many energy-efficient sensing approaches with adaptive sensing policies have been proposed to minimize the energy consumption [4] - [7].

Most research is done in individual domain like GPS, Activity Recognition and cellular tower triangulation.

In the general-purpose category, which targets the people who simply wants to track and visualize about their routes, Google's "My Tracks" is one of the most famous applications for Android O/S. It has to note that this application is a relatively simple tracker with no advanced features, however it has more than 10 million of downloads [1].

Jigsaw [6] uses the information gathered from the acceleration sensor and the microphone to continuously monitor the human activities and environmental context. Energy consumption in Smartphone is the major concern for the developers, long time in research, and number of studies are been done for improvement in energy efficiency of mobile devices [8].

EnTracked—is based upon the estimation and prediction of system conditions, mobility, and position updates a system will minimize consumption of energy and strongly optimize. This system equipped with GPS-enabled devices which tracks the target of pedestrians. The system is configured to be familiar with different trade-offs between energy consumption and robustness.

3. LBS TECHNOLOGIES

Various types of technologies used to track the location of Smartphone device are discussed here in this section.

A. Global Positioning System(GPS)

GPS works by collecting the signals from satellite which is revolving around the earth. GPS tells about the user's location. But GPS fails in the underground area or inside the building because there is no line of sight between the satellites. In addition Chon el at stated that in comparison with other sensors, GPS the power usage of is higher than others sensors.

GPS require communication with external location providers to get the users location but even if the users don't want to give his/her location, their location related information is provided to location providers. [9]

But the power consumption of GPS is higher than any other sensors. GPS cannot guarantee the exact location information it gives us the approximate information of the area of location.

B. Cellular Tower Triangulation

Cellular tower triangulation also helps in calculating the location information of mobile phone users. It calculates the information based on the signal of nearest tower from the user.

However it is less efficient in tracking location as it requires signals from three cell towers to form triangulation and by combining the results it predicts the information about the users location.

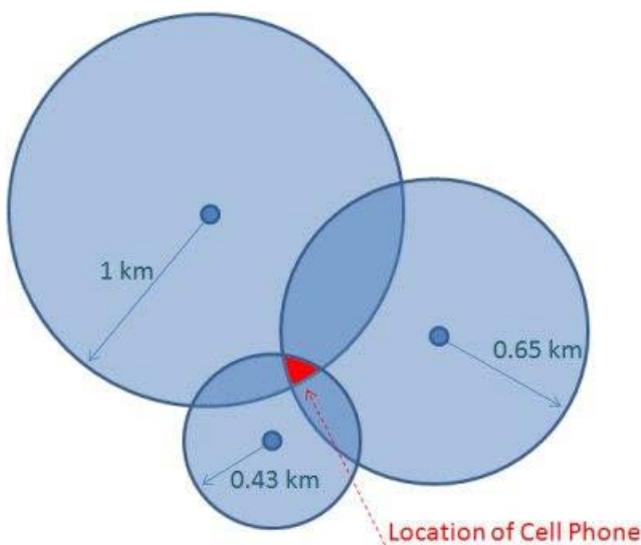


Fig 2: Cell tower triangulation predicting user's location

C. Activity Recognition

Activity recognition is the process of recognizing the actions done by one entity by the use of external or wearable sensors. Recently advancement in technology made Smartphone equipped with many sensors which made activity recognition easier. Activity recognition works by collecting raw data from the sensors to predict user's motion.

But collecting all the data is a waste, so data is preprocessed and only meaningful data is used to calculate the motion or orientation.

Many sensors are available but mostly two types which is accelerometer and gyroscope is used in activity recognition of users.

D. WI-FI(Wireless Fidelity)

Wi-Fi is also used for tracking user's location in a area where GPS is not available or not working. Wi-Fi is mainly used for connecting two devices wirelessly. Its

connectivity mainly depends upon its signal and coverage of signal.

Wi-Fi has low radio frequency signal which is easily affected by media and cannot penetrate through walls and buildings. Wi-Fi positioning system is mainly suitable for indoor location.

4. CHALLENGES

Various challenges in energy efficient location tracking are discussed in this section.

A. Limited Availability

It already known that GPS can't work properly in indoor environment. Standard GPS requires at least four satellite signals simultaneously to calculate the location. Mobile device should be in proper line of sight with GPS satellite which limits the usage of application. In the international border where there is no service of cellular operator leads to failure in tracking the user using cellular tower triangulation. Thus availability is big concern.

B. Accuracy

The accuracy of various localization techniques such as GPS, cellular triangulation, activity recognition, Wi-Fi varies in various conditions. As we know GPS accuracy is high but in case of rough weather or non availability of line of sight the results may differ. So use of more than one technology may guarantees the accuracy. Gabber et al. [10] utilized multi-channel records from GPS, satellite technology, cellular tower triangulation and Caller-ID, in a combined approach to find the position and activity of user devices but this can be bypassed easily as GPS signatures [11] are not very helpful since they are prone to spoofing attacks [12].

C. Power Consumption

Since the power of the mobile is very limited, power consumption of various techniques and technologies in tracking of location is a great issue. The technology such as GPS which consumes huge amount of energy is not preferred when battery level of mobile is low. So with the use of other alternatives we can solve the power consuming issues.

5. METHOD

There are three scenario introduced for energy efficient location tracking :

- 1 If battery capacity is above 50% system use GPS or any available technology.
- 2 If battery capacity is below 50% system uses Wi-Fi and cellular tower.
- 3 If battery capacity is below 20% system uses only cellular tower triangulation.

Based on this scenario energy efficient location tracking is done efficiently. Working of system is purely based on battery capacity of the Smartphone.

Algorithm:

Let GPS, Cellular tower triangulation, Wi-Fi and Activity Recognition be G, C, W and A respectively.

```
{
  Check battery life if > 50% then
    G or C or W;
  Else if < 50% AND > 20% then
    C or W;
  Else if < 20% then
    C;
  Else
    Battery not in capacity to use LBS;
}
```

6. CONCLUSION AND FUTURE WORK

As said earlier, existing research have proposed standalone in individual domain like GPS, Activity Recognition and cellular tower triangulation. The proposed system works based on the combine approach of GPS, Activity Recognition and cellular tower triangulation. Combination of GPS, Activity Recognition, Wi-Fi and cellular tower triangulation for tracking devices would give an energy efficient and accurate result.

Energy efficiency is the major concern, so by merging this distinct technology goal can be achieved. In this survey paper GPS, Wi-Fi, activity recognition and cellular tower is used by considering Smartphone battery life.

In this paper we present a comprehensive survey of a system which works using combination of GPS, cellular tower triangulation, Wi-Fi and activity recognition considering Smartphone battery capacity. Firstly we discussed Different forms of LBS technology. Many researches are done in the fields of technology to track a device, but main issue occurs which is not been considered is Smartphone battery life. GPS technology is the most popular and accurate Location based service. Drawback of GPS is its energy consumption which leads to alternative option for tracking devices. Nowadays, human's life is dependent on Smartphone; battery life is the prime concern, in which use of such energy consuming technology may not be an appropriate option. While Cellular tower triangulation, Wi-Fi battery consumption is also have effectively low consumptions of power. Combine use of this technology may lead to an effective system. When battery possess full capacity, system has a privilege to use any of the technology among available. During Poor battery capacity, system can eliminate energy consuming technology and run low energy consuming technology.

Considering battery capacity for switching location based service is motto of this paper.

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