VOL. 11, NO. 5, MARCH 2016 ISSN 1819-6608
ARPN Journal of Engineering and Applied Sciences

www.arpnjournals.com

IMPROVED BATTERY LIFE FOR CONTEXT AWARENESS APPLICATION IN SMART-PHONES

K. V. Davoudi[1], S. M. Daud[1], M. Khodadadi[1], M. A. Oskooie[1], H. Momeni[2] and M. Z. Adam[1]
[1]Advanced Informatics School, Universiti Teknologi Malaysia, Malaysia
[2]B-12-6 Fortune park, Taman Seri Perdana, Serdang, Malaysia
E-Mail: vahid_davoudi_e@yahoo.com

ABSTRACT

The new smart-phones with new operating system and portable sensors support the basis for context awareness systems and applications for handling user activity and user privacy. Nowadays, individuals need new services and real time information anywhere and anytime. Context awareness is an emerging service, which could be able to improve the user experiences in current situation. Context awareness can be considered as location, calendar, user activity and etc. The review of the literature proves that context awareness in mobile phone can be useful and studied as unavoidable service in next generation of smart-phone applications. In this paper, a short review about context awareness in mobile phone is studied, furthermore, we critically analyzed related works of context awareness in smart-phones. The review shows that the most important context in mobile phone is location, which is mostly obtained by using Global Positioning System (GPS) sensor in mobile phones but GPS can significantly increases battery consumption in mobile phones. In this regard, a framework as Improved Battery life in Context Awareness System (IBCS) is proposed to improve battery life and reduce cost of using GPS in context awareness applications based on smart-phones. The review argues the weakness and strength of these studies, and aims to (a) indicate the most important context in mobile phone, (b) reduce the battery consumption of GPS sensor in mobile phone.

Keywords: smart phones, context awareness, localization, battery consumption.

INTRODUCTION

A smart-phone is a mobile phone built on mobile computing platforms and offering hi-tech computing ability and connectivity [1]. Besides their processing features, portable sensors and memory have been improved. Today's smartphones contain high-speed data access, web browsers and, Global Positioning System (GPS) that is, a space-based satellite navigation that offers time and location. Furthermore, the new operation system of smartphones is offering new version of mobile services and the number of these services has been rising fast for smart-phones. Interestingly, the new generation of smart-phones employs the new operation system [2].

The new services and other new capabilities have been combined into smart-phones in support of user activities and social environment. Within this progressing movement, context awareness, which refers to a class of mobile systems that can senses their physical environment, and adapt their behavior consequently, has earned increasing recognition as one of the emerging technologies for the next generation of smart-phones [3].

Many researches have been studied context awareness based on smart-phones and offered new architectures and approaches but unfortunately, there is lack of practices and studies, and it need to take care of all features of context awareness in smart-phones. In this study, related works of context awareness in smart-phones are critically analyzed, and then the weakness and strength of these contexts are argued. We aim to discuss the structures of context awareness and show the most important contexts in smart-phones. Finally, a framework is proposed for improving battery life in context awareness's mobile applications.

CONTEXT-AWARE SYSTEMS

Context awareness was introduced in late 1992 within a project done by Olivetti named Active Badge [4]. Context awareness can be described as a program's ability of sensing, interpreting, detecting, responding and acting to different types of the environment like time, temperature and location [2]. Context awareness needs great management, which contains obtaining and determining the conflicts of context, which occurs obviously in ubiquitous computing. Context awareness systems are part of the wide computing environment and offers services and information to suit users needs by utilizing user's knowledge and user's data. For instance, the context may be related to where the user is or physical context. Context could be any data such as light level, noise level, network connectivity, communication costs, and even the social situation; whether you are with your manager or with a colleague.

Recently, many works have been done in context awareness in smart-phones. Lee and Lien developed a Context Awareness Information System (CAIS) based on smart-phones [5]. Their system contain of several services in smart-phones as follows:

1- Mobile information sharing
2- Location based communication
3- User privacy protection
4- Autonomous communication
5- Context awareness communication
6- Negligible cost

They indicated location as most significant context in smart-phones. Their goal was to make an ubiquitous environment for campus information system. They developed the system for small area, hence every user have to be closed to each other. The bluetooth is chosen as communication technology in this system, therefore the communication happening between the two devices is peer to peer and distributed, while they are closed to one another.

Some researchers worked on the understanding of context awareness and context data distribution infrastructure (CDDI) in smart-phones.

Corradi *et al*. studied on context data distribution infrastructure based on android smart-phones and emphasized on the implementation of specific basic context distribution [2]. They demonstrated a new experimental result to evaluate the run time performances based on android smart-phones. In their study, the designing issues of CDDI clients based on smart-phones is considered as main issue. Additionally, they developed a CDDI client for android platform. They focused on CDDI limitation and demonstrated the most significant concern in design of CDDI client is scare resources.

Some researchers believe smart-phones can help to carry sensors data. In this regard, Jayaraman *et al*. considered smart-phones as data carriers within a sensor network and focused about ability and capacity of smart-phones and presented it can make decisions based on context information [6]. In their work, a new environment Virtual Personal Area (VPAN) is introduced. The VPAN is appropriate to work with context awareness mobile node. Finally, an architecture is proposed in this regard. In their architecture, context part is the first step to the mobile node to find environment and location information. The server of the external context takes second step to the system, which is reachable to the mobile node as long as it is within the VPAN.

Fadzillah *et al.* carried out a research based on the current studies connected to the features of context awareness in different collaborative applications [7]. They focused on seven entities of context awareness as follows:

1- Tool
2- Device
3- Application
4- Method
5- Platform
6- Media
7- Framework

They worked on applications which have eight context elements as follows: the subject of context, kind of communication, digital elements, domain, locations, models, the kind of context, and the user's activities. They defined each context element's attributes and suggested a structure for context awareness in workplaces that are collaborative using these attributes. The structure is proposed to be able to use in wide perspective of context awareness because today's practice and work are limited in various circumstances.

Garg *et al.* demonstrated a mobile nodes' location capability [8]. They used identify codes of tower which are translated to Longitude and Latitude of Google's My Location API and all users are able to download this ability. They believe, this ability can be used for next generation of location service driven from the tower which are already exists. In their work, a conception of context and evaluating information across applying to the environment of smart-phones is studied. Their goal is to look for key application domains for use of context awareness.

Zhang *et al.* worked on Path2Go's services and algorithms as a multi mode traveling information system, which California PATH, UC Berkeley has developed [9]. They showed the results of activity detection algorithms of Path2Go were really good. Also they improved the Integrated Multimodal Traveler Information (IMTI) by utilizing context awareness service. They achieved better IMTI service based on context awareness by blending several data such as user information, vehicle information, and schedule information.

CRITICAL ANALYSIS

Literature shows that most of the context awareness systems are based on the location. Most of the context awareness application using location as the most significant context in mobile phone [5, 8, 13, 19].

As mentioned before, Lee and Lien designed a new system based on context awareness to achieve location based communication, mobile information sharing, user privacy location [5]. They believed there were no adequate classification services in smart-phones mainly in spam classification. In addition, their system is designed to deploy the information within the lowest cost, direct the information to the right people. They believed this system can help to smart-phone users to receive only the information they wanted at the right time automatically. Bluetooth was chosen in this system as communication technology but Bluetooth increases battery consumption in smart-phones [10]. In the other hand, most of the smartphones operation systems don't provide the device connect to other devices unless get confirmation from users or get pin-code authentication. So this system cannot be reliable because there is a potential of connection failure since Bluetooth covered 10-meter only [11].

Fadzillah *et al.* studied on features of context awareness [7]. They have been worked in several application domains to determine the most significant elements, which are used in collaborative workspace. Based on these features a structure, which can be used in wide perspective of context awareness, is proposed. However, the structure has not been tested yet; participants should be aware about use of this service until there are more researchers about finding. Besides users of this structure need to consider this structure can increase

VOL. 11, NO. 5, MARCH 2016 ISSN 1819-6608
ARPN Journal of Engineering and Applied Sciences

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battery consumption because this structure keeps WIFI or Mobile Data connected [11].

Some researchers studied to show how to cover all aspects of general need of context computing. In this regards, Garg *et al.* proposed a framework which offer a Location-Based System (LBS) based on Global System for Mobile communication (GSM) [8]. To get mobile coordinates, Based positioning Towers (BTS) are used. However in their framework accuracy of location can be dropped significantly [13]. In the other hand, LBS is insufficient to distinguish context of users, for example when only GSM location data of a user is provided near a train station, a LBS cannot be able to identify whether the user is driving by train stations, or waiting at the bus stop for next train, or has just taken a train and left the station.

Table-1. Process parameters and their levels.

Researchers	Finding	Limitation/Weakness
(Lee and Lien, 2009)[5]	➢ CIAS system is proposed based on context awareness to deploy information with the lowest cost, make sure messages are passing without fear of manipulation and get information to the right people at the right time	➢ Finding has not been replicated in other studies ➢ Battery consumption ➢ Bluetooth limitation ➢ Reliability
(Fadzillah et al., 2012)[7]	➢ Proposed a structure for wide perspective of context awareness in smartphones	➢ Has not been tested yet ➢ Indoor limitation. ➢ Battery consumption
(Garg et al., 2011)[8]	➢ To cover all aspects of general need of context awareness a framework is proposed based on location. ➢ Utilizes GSM	➢ Accuracy limitation ➢ Finding have not been tested yet ➢ Inference context limitation
(Zhang et al., 2011)[9]	➢ Improved the integrated multimodal traveler information (IMTI) service by using context awareness service	➢ Usability ➢ Battery consumption ➢ Indoor Limitation

Zhang *et al*. improved Integrated Multimodal Traveler Information based on context awareness [9]. For activity detection purposes, they blended GPS data from transit vehicles and GPS data from smart-phones. However, this system cannot be used in many countries because of limitation access to GPS data from public transit vehicles, also in many countries public transit vehicles are not equipped with GPS sensor. In the other hand, this system keeps GPS connected in background all the time, which would increase battery consumption [14]. Table-1, illustrated a brief findings and limitations which have been found in literature review. MOSFET processes typically have a large number of process parameters (control factors). The more complex a process is, the more control factors it has and vice versa. For each factor, normally two or three levels are selected for the appropriate orthogonal array (OA). The level of control factors is decided by their level of sensitivity. Table-1 shows the process parameters and their appropriate levels for the experiment.

DISCUSSIONS

The literature indicates that the most important context in smart-phones is location [7, 8, 9]. Most of the context awareness applications and researchers utilize GPS technology for localization issue [15, 16]; GPS increases energy cost which can decreases smart-phone's battery life to less than nine hours [17, 18]. In addition, GPS has limitation in indoor areas. In this study, we proposed a framework to decrease GPS energy cost in smart-phones (Figure-1). In this regard, GPS is disconnected by system/user when user stable for more than 10 minutes because user's location is constant and context aware application can utilize current location unless user is decided to move. When system diagnose user are moving, the system turns on GPS or asks user to do it. For this purpose, accelerometer sensor is utilized to distinguish user's motion. Furthermore, system turn GPS off or asks user to turn it off when user stays indoors and there is no signal for GPS and afterward asking to turn on GPS when leaving the building.

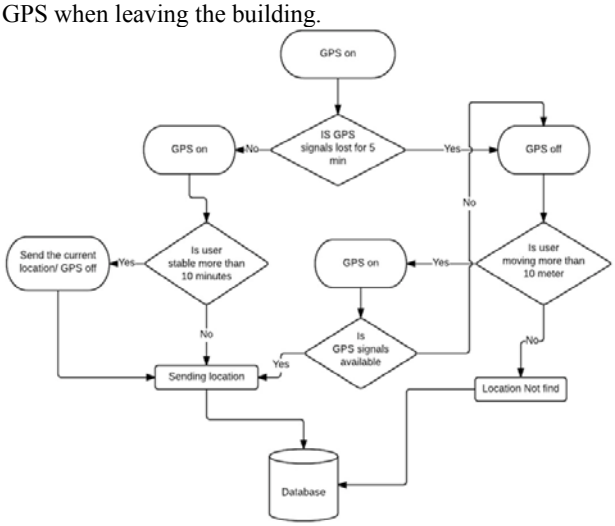

Figure-1. Proposed framework.

We believe that this system reduces battery consumption, which is among the main issues in many context awareness applications and systems. To test the basic operation of the IBCS, we ran experiments where each device runs a an advanced call blocking application

which opens a long-running GPS connection and then sends a location to the context database per second.

EVALUATIONS

To test the basic operation of the IBCS system, the experiments has been done on three diffenet smart-phones which are Samsung Galaxy Grand, Samsung Galaxy S3 running Android 4.0 and HTC 1 running Android 4.1.2. We chose android because for its popularity.

All of these three devices run an advanced call blocking application which opens a long-running GPS connection and continueusly sends the Location to the context database. Our observation shows the consumtion of the battery life considerably is reduced.

After deploying IBCS system to the smart-phones, we experienced that battery life increased to mores than 4 hours. This result is illustrated in Figure-2.

Participant	Battery Life without IBSC (Hours)	Battery Life with IBSC (Hours)
Galaxy Grand	8	11
Galaxy S3	9	13
HTC1	11	14

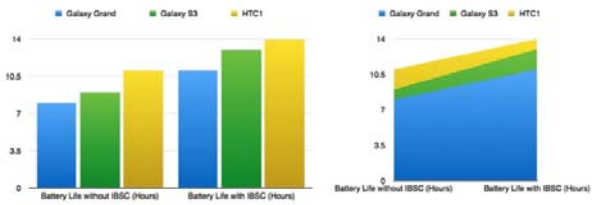

Figure-2. Evaluation Result

CONCLUSIONS

If the phone is smart enough to identify user context, then it can prevent some risks, which happen in some situations. For instance, consider user forgets to switch off his mobile phone while he is in an important meeting, or the risk of answering a phone call while driving. In this regard, one of the novel methods which makes smart-phone much smarter than before is context awareness. In this article, we studied current researches about context awareness in mobile phone and the area they have been applied and also give a short review about these subjects. Furthermore, we analyzed these articles and discuss weakness and limitations on these studies. Literature explores the importance of the location as the utmost importance context for mobile phone [19, 20]. however localization leads to cost of battery consumption; hence a system as IBCS is proposed to reduce battery consumption. Findings indicate that still there is shortage of empirical studies and practices, and it requires more concerns in this regard.

ACKNOWLEDGEMENTS

We would like to express our gratitude to Ministry of Education for providing financial support (research grant 4F357) in conducting our study. We would also like to express our appreciation to Universiti Teknologi Malaysia (UTM) and specifically Advanced Informatics School (AIS) for realizing and supporting this research work.

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