Using extended web technologies to develop Bluetooth multi-platform mobile applications for interact with smart things

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ABSTRACT

Nowadays the classic web paradigms are being subjected to changes; every day millions of users around the world use their Smartphones to access web applications from anywhere. The World Wide Web it is one of the biggest repositories of information in the world, and that information is stored in internet servers and repositories, but today in the real world there are many other information sources such as electronic devices with communication capabilities: smart appliances and sensor networks. The Smartphones are equipped with communication hardware elements like the Bluetooth module, which allows the Smartphone to exchange information with nearby electronic devices. Every day more and more mobile applications are being developed for native platforms that use Bluetooth's communication module to send and receive information from different sources. Native mobile applications use the specific platform's APIs to manage the Bluetooth communication actions (send and receive information, search for devices, etc.), however, web applications do not have technical capabilities to manage the Smartphone's Bluetooth communication module and thereof cannot use that kind of information. The main objective of this research work is to design a novel framework that allows classic web applications to use information from nearby electronic devices. The proposed framework must be easy to use and able to be integrated with common web technologies. Developers can use this framework to include new information sources and data exchange procedures in an easy way. The new type of information can be merged with the web to develop or improve algorithms and web applications.

1. Introduction

Information fusion refers to the study of techniques that combine and merge information and data residing at disparate sources [1–3]. The information fusion is present in many technological areas, including the World Wide Web, where different types of information fusion play an important role. The web influences almost every aspect of businesses and our daily lives [4].

In many senses, Smartphones have become a revolution within the last years. The increase of the computing and communication capacity of these devices allows them to perform a wide range of tasks. Millions of users use their Smartphones daily to perform lots of tasks, such as internet access, global positioning systems, multimedia, smart homes control [5], remote control [6], and patient monitoring [7]. Among the current mobile platforms we must highlight Android, iOS, Windows Phone and Blackberry, which

are the target of millions of mobile applications that are distributed via app stores. Many of these mobile applications merge information from the internet with other information obtained by using the phone's hardware elements, such as Bluetooth, Wi-Fi, sensors, and GPS.

The power of processors and the hardware communication elements of the Smartphones have made possible for many mobile applications to base a large part of its functionality in the exchange of information with other nearby electronic devices, thus enabling the development of context aware applications. Within the field of wireless communication technologies, the Bluetooth is one of the most used. Currently, most of the Smartphones include this technology. This communication standard is used to communicate devices both at industry [8] and at home [9], and it is also common to use it in multiple remotely controlled systems for fields like robotics [10] and telemedicine [11].

The most popular mobile application markets contain many applications that exchange information with nearby electronic devices, such as Smart Remote Control, LG Bluetooth Remote,

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Samsung Remote, DSLR Remote Controller, Logitech Squeezebox Controller and NXT Remote Controller, among others. This type of data exchange functionalities becomes very useful nowadays and the acceptance of many of these applications is reflected in the number of users, ratings and reviews provided. Samsung Remote Android application has gained more than 750,000 users in the second half of the year 2011. Currently, these mobile applications often exchange information with sensors, networks, home appliances (Smart TVs, Smart fridge, monitor electricity consumption, etc.), Bluetooth accessories, health monitoring devices, etc. But the number of physical objects that include communication mechanisms is growing rapidly; these objects are commonly called smart devices or smart things. These smart devices are one of the key pieces from the internet of things (IOTs) paradigm that promotes systems based on the communication between smart devices [12].

From the development point of view the management of the Smartphone's communication modules is done by using a platform's own API. Currently, the most popular Mobile Platforms are: Android, iOS (iPhone), BlackBerry OS, Symbian OS (Nokia), and Windows Phone 7 & 8 and Bada (Samsung), therefore, native applications are the only ones that usually include this type of information exchange. The mobile market is currently divided in multiple mobile platforms. In many cases, the notable differences between platforms (programming languages, APIs, interfaces, etc.) mean that in most of the cases, if the developers want to create a mobile application with repercussion on a large number of users, they should develop the same application multiple times, following the procedures for each mobile platform.

If we intend to make possible for a great number of users to exchange information with the smart electrical appliances of their kitchen via Bluetooth it is probable that we have to develop a native mobile application for every platform, adapting to each user's mobile platform. These applications would have a very different implementation in lots of its modules, as the management of the communications via Bluetooth will depend on the platform (specific classes, packages, methods, listener, authorizations, etc.). The mobile platform sector's current heterogeneity implies that, in order to offer mobile applications with advanced characteristics (such as the access to hardware communication modules) and make possible for the user community to use them, it would be necessary to multiply the development processes. This involves a very expensive process, as it requires to re-implement the same application several times and forces the developers to have knowledge of the various peculiarities of each platform.

The Smartphones users cannot only use native mobile applications, but also web applications. Implementing and maintaining the same application on multiple mobile platforms involves high development costs, so far that sometimes many mobile developers choose to develop their applications as web applications. With this strategy they are not only able to reduce development costs but they also increase the number of potential users, because the application can be used on any mobile device that has a web browser, regardless of the mobile platform [13]. But the nature of web applications makes impossible for them to manage the mobile's communication hardware, so the data exchange process with other electronic devices using Bluetooth cannot be performed. Native mobile applications can use the platform API, while web applications cannot. These APIs can communicate directly with the device's hardware elements, including: sensors, cameras, Wi-Fi and Bluetooth communication elements [14]. These hardware elements can allow the capture and exchange of many different types of information; it is very different from the classic information that is commonly used on the web.

There are other approaches based on the using of distributed mobile applications, like PhoneGap [15,16]. This type of distributed applications could be considered hybrids of native and web applications in many ways, because they use web technologies and a set of specific libraries to develop an application for a specific mobile platform. The specific libraries provide many of the mobile communication features that the web technologies lack, such as access to the Smartphone's Bluetooth module to send and receive information. But in any case, applications built with these hybrid platforms can be considered as hybrid web applications. They simply extend web technologies to make them useful for developing mobile applications. These types of platforms do not aim for the current web applications to exploit the hardware features of Smartphones, like Bluetooth, for getting information from new sources.

The main objective of this research work is to design and develop a framework that allows classic web applications to integrate information from nearby electronic devices, such as smart appliances and sensor networks. With this novel approach, the classic web applications will be able to use information from new sources, allowing them to implement new features depending on the information from the user's physical environment, such as nearby electronic devices. This framework must be easy to use and should be able to be integrated with existing web technologies. The aim is to make possible for developers to use this framework in order to include new information sources and new data exchange procedures in an easy way. The new information will be used to develop or complete algorithms and applications on the web. This approach gives developers the possibility of merging the web information with information from different nearby electronic devices.

This proposal is based on the use of extended web mobile applications which contain a series of specific XML tags that make possible to model all the Bluetooth communication's actions (search for devices, send information, receive information, etc.) in a fast and particular way. This tags contained in the web applications are combined with the use of traditional web technologies and are interpreted by a particular module of the web browser called "communication actions module" that accesses the Bluetooth communication module from the client mobile device, enabling the exchange of information with nearby electronic devices.

2. Related works

The use of mobile devices to control some functions of other electronic devices comes from a long time ago, in 1997 at Carnegie Mellow University's the Human–Computer Interaction Institute (HCII) launched the Pebbles project one of the pioneers systems based on the use of PDAs as effective remote controls [17].

In these last years, the number of electronic devices that are equipped with the necessary hardware to send and receive information from other devices (such as mobile phones) has increased greatly (home and office appliances) [18]. The technological evolution of the involved devices has led to several different kinds of information exchange and control systems. There are many factors that can determine the system's structure, such as hardware and software components, the system objectives, device specifications, communication types, and environment features.

Home networks are the target of many commercial and research projects that use mobile devices to exchange information and remotely control other nearby electronic devices. Usually, these systems have some limitations such as heterogeneity of controlled devices that use different protocols: X-10, Bluetooth, Universal Plug and Play (UPnP) [19]. Among the different kinds of control systems we can identify, there are some that use web servers and services to provide a centralized control environment capable of managing multiple different devices. Most of these web systems focus on network appliances [20]. Many of these systems