

The 8th International Conference on Emerging Ubiquitous Systems and Pervasive Networks
(EUSPN 2017)

All for One and One For All: Dynamic Injection of Situations in a Generic Context-Aware Application

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Abstract

In a new smart-world, users are getting accustomed to fast-responding applications that make their everyday tasks and daily life easier. In order to meet their expectancies, mobile applications are shifting towards a new era of context awareness. Nonetheless, it seems that context-aware applications are still struggling to provide the user with a real situation understanding. They only consider non-evolving limited scenarios and react to them using only generic services. To address these concerns, we have developed the Long Life Application, a dynamic context-aware situation-based distributed mobile application dedicated to assist end-users in their everyday needs. This application considers the requirements of the users and provides them with the appropriate services according to their current context. In this paper we focus in the way that the user's context is considered by the application. We propose a hybrid approach that combines both high-level context (top-down approach), by injecting user-related context, and a low-level context (bottom-up approach), by inferring it from sensor data.

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Peer-review under responsibility of the Conference Program Chairs.

Keywords: Context-aware mobile applications, Pervasive applications, Situation awareness, Reactive systems.

1. Introduction

Nowadays, mobile devices are packed with a large amount of applications for multiple purposes. These applications try, in their own categories (social, work, entertainment, etc.), to fulfill the needs of the users. But the diversity of those needs makes it a challenge for mobile applications to accurately understand them and respond to them. This issue highlights the need to have context-aware applications able to understand the users' context and with the capability to translate their needs into services. Although some existing applications tackle this challenge, they are most of the time unable to behave in the way expected by the users because they limit their focus to specific domains (museum guided tours², context-aware shopping¹², transport, etc.) and then just offer specific services for those domains. Those application do not consider that users' needs are always changing, and therefore many of the services that are

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automatically offered by them are not adequate for the users. In this context, the need to develop mobile applications that are able to understand the user and manage his/her daily situations regardless of their nature or categories, arises.

The objective of this paper is to present how the developed user-centered, distributed, context-aware (situation-based) mobile application, called Long Life Application (LLA), is able to create/inject/detect everyday situations and react to them dynamically, thus providing the appropriate services for the users. The main novelty of the work presented in this paper is a collaborative mechanism that enables users and other external sources to continuously and pro-actively introduce new situations into the user's application, in order to improve its understanding and reliability and overcome the lack of dynamicity in current context-aware applications, which causes that only 25 percent of users return to any given application after the first use⁶.

This paper starts in Section 2 by presenting related work on mobile applications focused on context awareness dedicated to mobile end-users. Then, Section 3 summarizes the architecture that sustains our proposal and the basics of the proposal's situation-based contextual modeling. After that, Section 4 is focused on the context injection mechanism used to enrich the application dynamically. Section 5 shows a scenario where the proposal is evaluated by verifying its feasibility. The paper finishes with some conclusions about the proposal and some prospective lines of future work.

2. Related Work

After an exhaustive study of context-aware applications dedicated to everyday users, we found a myriad of early solutions^{8,19}. More recently, companies like Google took an interest in this area due to its beneficial impact on the user's experience. Google Now¹³ is an app triggered by contextual changes or voice commands. It detects and gathers relevant data about users and saves their Google searches using the Google Knowledge Graph⁵. Likewise, Grokr¹⁶, Osito⁷ and Tempo¹⁸ focus on context-aware recommendations (predictive search engine) and notifications. Nonetheless, these applications do not consider the possibility of expressing declaratively the user's needs and are limited to notifications and recommendations as services.

IFTTT¹⁵ (IF This Then That) and Google Instant Apps¹¹ are two of the most interesting solutions based on pre-set triggers. They consider the user's devices and exploit them by using services or bundles able to be deployed on remote devices (e.g., connected lights). The drawback is that their applicability is limited to rigid use cases defined only by developers.

Rule-based systems, like Sense Everything Control Everything (SECE)¹, are frameworks for context-aware service composition that enable users to define the context by using written sentences. Even though SECE is user-friendly, inputting rules manually is a constraint, due to the need for natural language processing for interpreting the definitions (for all spoken languages).

Other works tackle the problem of Human Activity Recognition (HAR) dedicated to context awareness. Several proposals^{10,14,17} use devices, sensors, sound and cameras to detect and understand accurately the physical activity of the user (e.g., walking, running, eating, typing). Nonetheless, most of them require the user to be surrounded with sensors and wearing some kind of connected device all the time, which can be irritating in certain situations.

As opposed to existing works, the LLA proposal implies the use of a single application for everything, able to adapt dynamically to the current context and be extended with the definition of new relevant situations.

3. Application Framework Architecture and Situation Modeling

The Long Life Application (LLA) is basically a transparent application that starts once and continuously (long-life) monitors the user's context in order to offer him/her with the appropriate services when/where needed. The LLA was defined in our previous work⁹, that focuses on the context formulation and the definition of the LLA's architecture. It differs from the classical approach by making the services go to the user. Thus, the LLA is context-aware and distributed on the devices of the user. In order to offer context awareness, the application is able to detect the context of the user and react accordingly. Hence, in the first step, it collects information about the user and feeds it as an input. The application is based on a modular architecture (framework) that is able to detect, understand, and react to changes in the environment by offering to the user services related to his/her needs. The growth of the network of smart connected devices requires the application to consider the features of ubiquitous and pervasive computing. These

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