

Collaboratively assessing urban alerts in ad hoc participatory sensing

Fátima Castro-Jul*, Rebeca P. Díaz-Redondo, Ana Fernández-Vilas

Universidade de Vigo, Campus Universitario s/n, Vigo, 36310, Spain

ARTICLE INFO

Article history:

Received 5 September 2017

Revised 28 November 2017

Accepted 19 December 2017

Available online 20 December 2017

Keywords:

Event detection

Participatory sensing

Opportunistic sensing

Smart city

ABSTRACT

Ad hoc architectures have emerged as a valuable alternative to centralized participatory sensing systems due to their infrastructure-less nature, which ensures good availability, easy maintenance and direct user communication. As a result, they need to incorporate content-aware assessment mechanisms to deal with a common problem in participatory sensing: information assessment. Easy contribution encourages users' participation and improves the sensing task but may result in large amounts of data, which may not be valid or relevant. Currently, prioritization is the only totally ad hoc scheme to assess user-generated alerts. This strategy prevents duplicates from congesting the network. However, it does not include the assessment of every generated alert and does not deal with low-quality or irrelevant alerts.

In order to ensure users receive only interesting alerts and the network is not compromised, we propose two collaborative alert assessment mechanisms that, while keeping the network flat, provide an effective message filter. Both of them rely on opportunistic collaboration with nearby peers. By simulating their behavior in a real urban area, we have proved them able to decrease network load while maintaining alert delivery ratio.

© 2017 Elsevier B.V. All rights reserved.

1. Introduction

The Smart City paradigm conceives the city as an intelligent and connected environment where information technologies are embedded everywhere, constantly monitoring what is going on in order to inform about and take care of any incident that may take place. The rise of sensor-rich smartphones, ubiquitous nowadays, has turned citizens into sensors of their own environment [1], enabling the birth of participatory sensing [2] and crowd sensing schemes [3,4]. Since these systems rely solely on users' contribution to gather context information, they do not require a dedicated infrastructure and therefore, they are an inexpensive alternative to collect data about the whole city. Users' involvement makes sensing systems flexible and rich as diverse views can be considered. Therefore, users' participation should be encouraged and simplified to maximize data gathering and its diversity. However, easy contribution may result in large amounts of information, which may be incorrect, irrelevant, low-quality [5] or redundant [6].

Data quality assessment is a problem common to every grassroots-based scheme but it becomes more complex in systems where there is no central entity in charge of processing the gathered information. That is the case of totally ad hoc participatory sensing [6,7], where users communicate directly with each other in a distributed way. These systems are generally targeted at

spreading event alerts to nearby users in highly-populated urban areas or when traditional networks are challenged. In absence of a filtering entity that decides what is worthy to be disseminated, every generated message is sent to all users, whether they are interested or not. As a consequence, multiple messages increase network load without adding any benefit. In a crowded scenario where many users are spreading news about a certain event, the network may get congested and collapse. As a result, some users may not receive the alerts. Ironically, too much information may prevent them from being informed. There exist solutions [8] based on hierarchical mechanisms, which reduce the problem while imposing a setup cost that makes the system not as flexible. An alternative that maintains the network flat is content-aware prioritization [6]. However, this strategy focuses only in redundant information and does not target messages dissimilar to others but of low-quality. Moreover, it does not evaluate every message but it is only triggered when a significant number of messages are already in the network. As a result, it does not deal with the problem thoroughly.

To deal with the problem of low-quality data in ad hoc participatory sensing and prevent unnecessary transmissions, we have developed collaboration schemes that involve neighbor nodes in the assessment of information pertinence. Unlike other systems, assessment is performed in a distributed manner without any centralized entity or hierarchical structure. Moreover, it includes the evaluation of every user-generated message before being disseminated. Our objective is to reduce the network load required to in-

* Corresponding author.

E-mail address: fatima@det.uvigo.es (F. Castro-Jul).

form other users on a certain event. We aim to do so by reducing duplicate and irrelevant messages; in other words, by improving the quality of the participatory sensed information. In this paper, we present the design and evaluation of two different collaborative mechanisms, which differ in the level of neighbor cooperation they require. One of them had already been briefly introduced in our previous work [9]. We examine in depth the problems of information assessment and opportunistic collaboration in participatory sensing and we detail the operation of both strategies. Furthermore, we have conducted network simulations based on real urban scenarios in order to assess their performance.

This paper is structured as follows. In Section 2, we start by providing an overview of participatory alert systems and we discuss how information assessment and opportunistic collaboration have been dealt with in this field. Then, we describe our target scenario (Section 3) and we detail our approach (Section 4). In Section 5 we describe the evaluation process, which is discussed in Section 6. Finally, we finish by outlining our conclusions and future work (Section 7).

2. Participatory alert systems

The aim of participatory and crowd sensing is to collectively gather information. This information is employed mainly for two purposes: *decision making* and *visualization and sharing* [4]. The former approach is meant to form collaborative knowledge, to be used by the very contributors or by a central entity in charge of aggregating and processing the data. Decision making applications include object recognition, recommendation and prediction. In systems targeted at *visualization and sharing* the information gathered is meant to be distributed to other users besides the contributors. Applications include sharing users' monitoring results to motivate them by competing with peers [10], creating collaborative knowledge to be made publicly available [11] and disseminating information on detected events. These last systems are alert systems, particularly interesting in smart cities, where citizens benefit from being always aware of what is happening around them. In these systems, users disseminate alerts, which are notifications of events or incidents that draw their attention. The range of possible alert topic is broad, from earthquakes [12] to potholes [13]. Moreover, it includes not only potential unsafe situations but any other kind of unusual happening, like street shows or demonstrations. There exist a great variety of alert mechanisms, considering different architectures and degrees of user involvement [4]. According to these two criteria, we establish the following categories of event detection and dissemination schemes:

- **Centralized explicit.** Users with a specific application in their phones share information with a central entity in charge of gathering and processing the information. Information can be sent manually by users themselves or automatically when a certain sensor reading is triggered [13]. Once processed, the information is made publicly available [11] or sent to users that have either subscribed to the service or queried for information [14].
- **Centralized implicit.** Users share information on events but not with the explicit intention of contributing to the system. In other words, they are not aware of the sensing task. Event detection is normally performed on online social networks information using data mining techniques to find meaningful events. As in the centralized explicit scheme, information can be spread to interested users [12] or publicly distributed.
- **Ad hoc.** Users detect events and share information directly with their physical neighbors, using short-range communication technologies [6,7]. Thus, ad hoc systems are always explicit and do not include a central entity in charge of data gather-

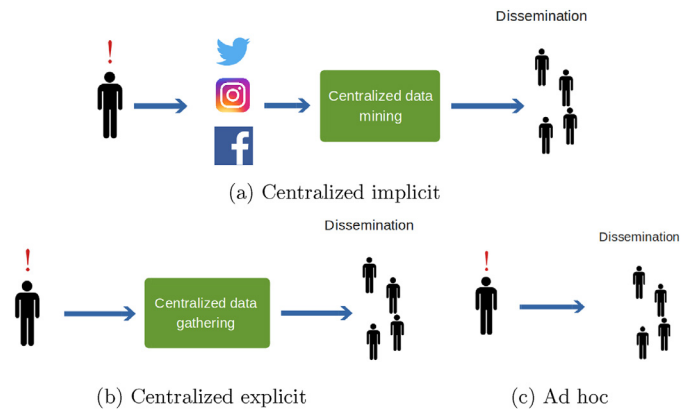


Fig. 1. Participatory sensing alert systems.

ing and processing. However, users may form hierarchical structures or clusters, with a leader that plays this role locally [8].

What we define here as *alert systems* has been referred to in the literature with different terms, such as situation awareness systems [6]. Systems based on social networks are described as event detection systems since they often do not deal with the dissemination phase. Explicit systems are commonly described simply as participatory sensing, without mention to the application they target. We consider all these systems as a whole since, even though they may not thoroughly cover the alert process, they play a part in leveraging user-generated information to detect events and spread the word about them. The architecture of a complete alert system using every one of the architectures above is shown in Fig. 1.

2.1. Information assessment in participatory sensing

Event detection and dissemination have attracted researchers attention over the last few years. Due to the big amount of data available nowadays, special attention has been paid to data mining in social networks [12,15,16]. Data from social networks, especially Twitter, is processed in order to find trends or bursts of information [17,18] that may correspond to relevant events. Supervised classification is another usual detection technique [19]. Thus, these approaches benefit from handling as much data as possible. Irrelevant data is discarded and de-duplication, performed using clustering methods, is only considered as a pre-processing method to decrease the amount of messages to be dealt with [15,20].

Explicit alert systems rely also on a central entity in charge of processing gathered data and therefore of assessing alerts by comparing them with others. They may assume all them as correct and always trigger the alert, but only the first time it is received to prevent duplicates. Other processing techniques can include only triggering the alert if a certain number of users has corroborated the information [13]. Anyway, this strategy also benefits from receiving as much data as possible since it improves event recognition and does not imply flooding the network.

In contrast, ad hoc alert systems do not benefit from large amounts of data as they may cause problems and even the collapse of the network. Research focus in this area is, in fact, targeted at how to decrease the amount of messages sent while maintaining the ratio of delivered information. In the alert case, this implies sending fewer alert messages while not missing relevant events. Work in this field has been mostly focused on efficient routing or dissemination techniques [21–24], instead of filtering the content that is being disseminated. Messages are, in general, assumed to be relevant and it is up to the nodes to decide whether they should start alert propagation. However, the idea of implementing filtering

Download English Version:

<https://daneshyari.com/en/article/6882804>

Download Persian Version:

<https://daneshyari.com/article/6882804>

[Daneshyari.com](https://daneshyari.com)