Here-n-Now: A Framework for Context-Aware Mobile Crowdsensing

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Abstract. We propose, develop and demonstrate Here-n-Now, a fully extensible and customizable framework to support context-awareness in mobile crowdsensing applications. A demonstration video for Here-n-Now as well as the binaries for download and installation of the mobile client and information for download of the mobile application from the Android marketplace are available at: http://mobilemining.monash.edu.au/Here-n-Now/. We intend open source release of the libraries.

1 Introduction

Mobile crowdsensing focuses on leveraging the plethora of sensors in smartphones to collect information from a large group of mobile users and analyse/use that information for the benefit of the group. Numerous real and successful mobile crowd-sensing applications have have started to emerge to such as WAYZ (http://www.wayz.com/) for real-time traffic/navigation information, Wazer2 (https://www.wazer2.co.il/) for real-time, location-based citizen journalism, macrosense (http://www.sensenetworks.com/macrosense.php) and bump (http://www.newurbanmechanics.org/bump/) among others. The typical issues that have to be addressed in performing mobile crowdsensing are: (i) Mobile devices are required to continuously sense, process and upload sensed data to the cloud/remote servers, (ii) data collection should be cost-efficient for both the devices and the networks, (iii) infrastructure and techniques for scalable management and analysis large volumes of real-time data streams, (iv) participation from the user and willingness to allow collection of sensor data, and (v) personalization for catering the applications to the user’s real-time needs. In [2], we have developed the Context-Aware Real-time Open Mobile Miner (CAROMM) engine that addresses one of these research challenges, namely highly scalable and efficient data collection for mobile crowdsensing by leveraging on-board mobile data stream mining algorithms to reduce the amount of data transmission, while still maintaining accurate levels of information being sent.

In this paper, we propose, develop and demonstrate our Here-n-Now innovative mobile crowd-sensing framework that uses CAROMM’s scalable data collection engine to deliver real-time and situation-aware location information for
mobile users. The aim is to enable mobile users to establish in real-time the current levels of activity, noise, and liveliness at any location from which participatory sensing is occurring. Thus, we aim to be able to answer queries for users who wish to go jogging in a park but want to make sure that there are other people in the location at the moment (for safety reasons) or users who wish to go for dinner with visiting colleagues (and want to get a drink in a quiet pub where they can have work related discussions). We emphasize that while the demonstrated application is focused on real-time situation information at places of interest, the underlying framework of Here-n-Now itself is generic and is the first integrated framework that facilitates the development and evaluation of a variety of research applications in context-aware mobile crowdsensing.

The Here-n-Now framework has the following innovative features: (i) it includes a highly energy-efficient and scalable data collection approach for mobile crowd-sensing, (ii) it captures in addition to sensory data, the mobile activity of the user (e.g. walking, running, sitting, etc.), (iii) utilises both sensory data and user activity data as context for inferring the current situation at places of interest, (iv) includes a cloud based context-reasoning engine for processing real-time continuous data received from mobile devices, and (v) correlates mobile sensory information to information from social media in real-time. A further significant feature of Here-n-Now is that it is a fully plug and play framework. Here-n-Now allows integration of a number of mobile activity recognition models on the mobile phone (thus, the current Neural Network based model can be replaced by any other) as well as a set of context reasoning engines on the cloud (again, the current Fuzzy Situation Inference engine can be replaced with any other technique). Furthermore, the mobile client, the data management component and the context reasoning have been engineered to enable easy de-coupling from each other thus facilitating extensibility and ease of application development.

2 The Here-n-Now Framework

Fig. 1 shows the Here-n-Now framework. The Data Collection & Analysis Module residing on the mobile devices captures sensory data, performs local continuous real-time stream mining on the data and uploads analysed information to the cloud where further analysis, management, and fusion of the incoming multiple streams needs to be performed. To intelligently send only analysed information from each device, we use our resource-aware clustering technique to identify significant changes in the situation. This module also includes the ability to plug in mobile activity recognition models (as can be seen in Fig. 1). In this demonstration, we have used a Neural Network based activity recognition model for recognising four basic activities - walking, running, sitting, and driving using the sensed accelerometer data.

The Context-Aware Data Processing Module residing on the cloud infers situations using the real-time sensory and activity data collected from mobile users. As shown in Fig. 1, any context reasoning engine can be integrated into Here-n-Now for situation inferencing. In the current implementation, we
have used our Fuzzy Situation Inference (FSI) model [1] which integrates fuzzy logic into the probabilistic Context Spaces (CS) model. FSI leverages fuzzy logic to deal with uncertainty associated with human concepts and real-world situations. The innovation of Here-n-Now is that it allows development of any number of mobile crowdsensing applications given its modular engineering and highly scalable and customizable architecture. In this demonstration, we model three types of situations based on the four parameters: noise level, activity level, light intensity, and crowd intensity -(i) lively: noisy and bright, may/may not be crowded, (ii) busy: crowded and high activity, may/may not be noisy, and (iii) quiet: low crowd level, less activity, and low noise level. This situation modelling is one example, FSI allows creation and use of different sets of situations as per the need of the application.

3 Demonstration Scenario

We consider a location information service that uses mobile crowd-sensing to collect sensory data and activity data from a large number of mobile users. Users interested to get the location information service are requested to allow participatory collection of sensory data and activity recognition based on the sensed data. Using the sensed data and user activity levels in different locations, our application is able to provide real-time reasoning about different situations/ambience of the locations. In this demonstration, we consider an application for selection of a venue for an evening out. We characterise different venues as lively, busy and quiet based on physical phenomena such as light levels, noise levels, estimates of crowd intensity, and user activity levels. A user can post a query stating a place of interest (say, bar or restaurant) in a particular location (suburb, city). Our application will then identify relevant places
of interest in/near that location and collect all uploaded data related to the places of interest. The sensory data and activity data are then used for situation inferencing in each of the places of interest. The places of interest along with their situations/ambience, and any current social media updates regarding that location are then returned to the user. Figure 2 shows screen shots of the application showing data collection, query, and results. The Here-n-Now Data Collection and Analysis Module is implemented on android-based smart phones using android SDK v2.2 (http://developer.android.com/sdk/index.html). The Context-Aware Data Processing Module is deployed in Amazon Elastic Compute Cloud (EC2)(http://aws.amazon.com/ec2/). Google places API is used to return places of interest nearby a location. The current implementation uses restaurants/bars/cafes category of places of interest, other categories can easily be integrated.

![Fig. 2. Here-n-Now Data Collection, Query and Results Screenshots](image.png)

4 Conclusions

We have presented Here-n-Now, a fully extensible and customizable framework, the first to combine mobile data mining, mobile activity recognition, and cloud based situation inferencing to support context-awareness in mobile crowdsensing applications.

References