Chapter 35
Cloud Computing Location-Based Services for Quality Health Care Services Delivery

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ABSTRACT

This chapter proposes a cloud computing location-based services system able to query points of interest, according to mobile users' preferences and contexts, under dynamic changes of locations. The contribution consists of providing software as a service based on Delaunay Triangulation on road (DT_r) able to establish the Continuous k-Nearest Neighbors (CkNNs) on road, while taking into account the dynamic changes of locations from which queries, enhanced by users' preferences and contexts, are issued. The proposed software, implemented on a mobile cloud and exploited by mobile physicians for healthcare institutions localization and selection, considerably improves the quality of services provided for patients in critical situations by permitting real time localization of adequate resources that may contribute to save patients' lives.

INTRODUCTION

Emergencies due to heart problems, fires, road accidents, terrorist attacks, toxic releases, etc., lead frequently to human deaths and serious injuries. Physicians can rescue critical cases if they can reach rapidly their patients and convey them to the appropriate health care institutions. The main questions are then:

1. How to localize rapidly the suitable health care institutions?
2. Do identified health care institutions enclose the necessary and available medical resources able to fulfill the patients' and physicians' needs?

The answer to the first question falls under the context of the determination of CkNNs, which can be exploited as cloud services, useful for many critical applications such as in commerce, leisure, healthcare, etc. Indeed, there exist several techniques of effective treatment of this kind of queries in a space

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of static data. Recently, research was focused on dynamic environments where the queries move on an unpredictable trajectory (e.g. mobile physician requests). The majority of the existing research assumes the metric of Euclidean distance; however, in the real world, the queries move in the road network where the measurement of interest is opposed to the Euclidean distance. Within this field, two principal conditions must be met for the determination of CkNNs. On one hand, the localization of the mobile query (e.g. a physician in his vehicle equipped with a mobile device and positioning system) and the localization of the static sites of interest (e.g. hospitals, emergency centers), are done with regard to the road network. On the other hand, the measurement of distance is defined as being the shortest way, and not the Euclidean distance, between the query point and the points of interest.

In this chapter, we propose a new method, to be implemented as a software as a service provided by a mobile cloud, aimed to deliver a valid result for the track of the kNNs. This approach ensures efficient updates for data and results of mobile queries. It permits, on one hand, the modeling of a road network through a triangulation and on the other hand, the restoration of a valid response for a continuous search of the kNNs (e.g. seek for me the three closest hospitals from my current position? Seek for me the two closest emergency departments from my current position?). The result of these kinds of queries is a set of points of interest (e.g. three hospitals, two emergency departments) localized in the road network map of a given town or village.

For a physician looking for necessary and available medical resources, this is not usually a sufficient response. In fact, more than determining the points of interest, the physician needs to distinguish whether these places have the necessary resources and whether these resources are available or can be made available. This constitutes an answer for the second question asked at the beginning of this introduction (Do identified health care institutions enclose the necessary and available medical resources able to fulfill the patients' and physicians' needs?).

Suppose that a physician usually travels from place to place, in a connected road network of a village or a town, to take care of his permanent and vocational patients who are geographically dispersed. The patients' states of health may vary and in time may become critical. The physician has to react quickly, as events are unfolding, to save his patients' lives. To achieve this objective, he must find the healthcare institution with the necessary medical resources in a reasonable time, while also taking care of his patient at home or work, or while travelling on one of the roads (e.g. in an emergency vehicle). This can be performed using mobile devices well equipped to query distant databases and to give efficient answers while moving. This can be ensured by cloud computing services able to provide efficient responses to location dependent queries triggered by mobile users such as physicians. Our proposed approach is able to help physicians to identify the nearest healthcare institutions or skilled staff. In fact, various queries can be sent to our system such as "find me the k-nearest health care institutions to my current position."

Answers to these requests are a set of points of interest which have to be displayed on the physician's mobile device screen. Moreover, while the physician is heading to the resulting points, he may browse the points' of interest contents, in order to have an idea about the medical resources available. He proceeds then to perform additional requests, leading to better decisions, such as making reservations for the needed medical resources (e.g. surgery room, medical hardware, etc.) at the point of concern (e.g. hospital), requesting some kind of skilled staff (e.g. specialized nurses, additional specialized physicians in surgery, etc.).

Nonetheless, selecting heath care institutions and browsing their associated medical resources and enquiring about their availability may take time and consequently threaten the patient life. The solution is to integrate physicians and patients contexts and preferences into the localization algorithm.