

[Poster Presentation] A Smartphone-based WiFi Monitoring System

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Abstract—As mobile crowdsensing techniques have attracted a lot of attention recently, an incentive scheme that motivates the crowd to actively participate becomes a key to the success of such city-scale applications. This paper presents a crowdsensing WiFi monitoring system, which helps smartphone users to find good quality WiFi hotspots. The quality information is defined in terms of user experience and hence the system requires users to contribute information of their experience with WiFi hotspots. To motivate people to contribute such information, we design and implement a gamification-based incentive scheme in our system. It allows a user to “conquer WiFi territories” by becoming the top contributor for WiFi hotspots at different locations. The contribution is based on the diversity and amount of data a user submits, for which he will be rewarded accordingly. We implemented our design on Android and it facilitates the collection of city-wide WiFi information provided by real users according to their actual experience.

Index Terms—Participatory sensing, crowdsourcing, smart city

I. INTRODUCTION

Mobile crowdsensing techniques have inspired many real-world smart-city applications such as traffic navigation systems [1] and urban noise mapping systems [2]. Some other systems provide coarse-grained information of WiFi hotspots [3] or cellular network coverage [4].

However, a big challenge in crowdsensing applications is to have an incentive scheme that motivates people to contribute sensing data. This work presents a crowdsensing WiFi monitoring system, that incorporates a gamification-based incentive scheme to reward users who contribute the most useful data based on the diversity and amount of the contributed data. Our system supports three modes: (1) offline search, (2) online review, and (3) gamification-based WiFi map. The offline search mode allows a user to search for a list of available WiFi access points around a queried region, even though he is not near the region. The online review mode allows a user who already connects to a WiFi access point to submit a review about his experience on that WiFi access point through his smartphone. The gamification-based WiFi map displays all the WiFi access points on a city map, but unlike other similar applications, each access point is represented by a user who has contributed the most useful information to it. Compared to existing systems, our system has the following unique features. First, it incorporates a gamification-based incentive to motivate people to contribute high-quality data [5], in which the reward system considers not only the amount but also the diversity of the contributed data. Second, our system collects real user experience—in terms of WiFi network quality and tagged by semantic places—as well as device-measured metrics such as signal strength and link speed, in order to provide more comprehensive WiFi-related information.

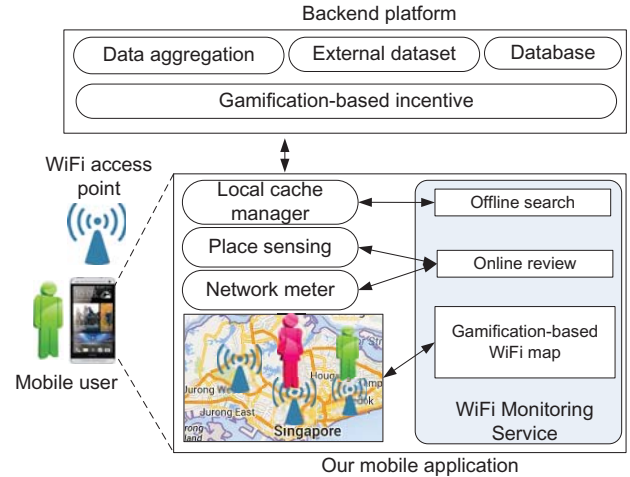


Fig. 1. The system architecture.

II. SYSTEM DESIGN

A. System Architecture

See Fig. 1. The front-end WiFi service cooperates with the gamification-based incentive to collect diverse and high-quality data. The back-end platform manages the collected data and evaluates users' contributions through four major components: database, external dataset, data aggregation, and gamification-based incentive. The database stores the raw sensing data and processed data. Not only our own dataset but also an external dataset from a government agency are imported into our system to enhance the WiFi monitoring service. The component of data aggregation clusters collected data based on the spatial correlation among them. The gamification-based incentive evaluates each user's contributions based on the data diversity submitted by the user and let all the users compete for rewards.

B. Front-end Design

The front-end sensing design consists of four major components: (1) WiFi monitoring service, (2) local cache manager, (3) place sensing, (4) network meter. The WiFi monitoring service guides people to find out “better” WiFi access point, collects user reviews, and provides users with a gamification interface to win rewards. The local cache manager maintains a lightweight database on each smartphone to support offline search. The place sensing captures the semantic place information associated with a WiFi access point, represented by a fine-grained location including street address, floor information, and room information, in order to facilitate a user to find the WiFi access point

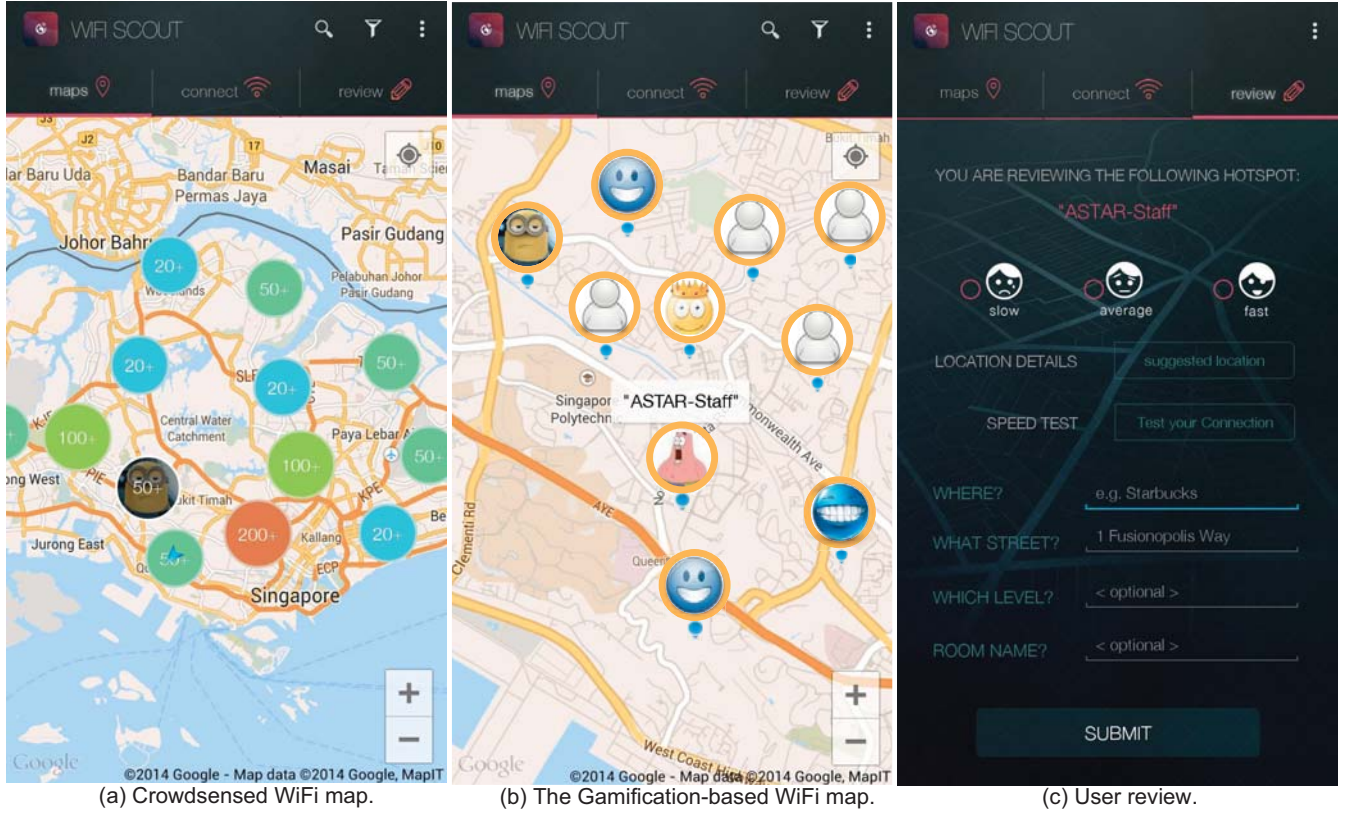


Fig. 2. Screenshots of the our mobile application.

easily. The network meter measures the connectivity quality of a WiFi access point including the signal strength, link speed, uploading speed and downloading speed, associated with its BSSID and SSID.

C. Reward Evaluation

The gamification-based incentive scheme evaluates user contributions according to the following rules:

- When a new user initially joins the system, the user will have R_s starting points.
- When a user u connects to a WiFi access point, say AP , and submits a user review for AP , he will be rewarded points of:
 - R , if u did not contribute any review for AP in the past;
 - $\frac{R}{2}$, if $\tau(AP, u) \geq T$, where $\tau(AP, u)$ is the time interval between this review and the previous review for AP submitted by u , and T is a predefined threshold; or
 - 0 , if $\tau(AP, u) < T$.

By these rules, a user who reviews many different WiFi access points with sufficient time interval in between (so that there is less correlation), and for a long term, will be considered by the system as a useful data contributor. Thus, the gamification-based incentive will rank users according to their reward points, and enable the top contributor for each WiFi access point to “own” that access point. As this process continues, such ownership will change according to each user’s contribution performance and, thereby, creating a gamification enthronement in which users

compete with one another to “claim” territories by placing their avatar pictures on as many locations as possible in a city map.

III. IMPLEMENTATION AND DEMONSTRATION

In the current implementation, we choose the threshold T to be 6 hours. Fig. 2(a) is the crowdsensed WiFi map where nearby hotspots are clustered together, with the number indicating the cluster size. Fig. 2 (b) is the gamification-based WiFi map where each avatar picture represents the top contributor for that particular WiFi access point. Fig. 2 (c) is the interface crowdsourcing for the user reviews on their WiFi experience.

The next implementation will enhance both incentive and trustworthiness aspects by incorporating a social-economic scheme called SEW [6].

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