A Mobile Application Leveraging QR-Codes to Support Efficient Urban Parking

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***Abstract*—In urban areas, finding a convenient place for car parking may determine a significant waste of energy, as well as environmental pollution. The introduction of proper software tools can indeed contribute to limit the environmental impact of inefficient car parking. By making use of a mobile application and a corresponding adequate information system, it is possible both to speed up the car parking process (from the user viewpoint), and to improve the parking areas' management. The application described here is characterized by some novel aspects: i) a QR code can be used to identify the parking spot, and to trigger the parking process; ii) a parking spot can be possibly reserved; iii) global information on parking occupancy can be made available to other applications to better manage services of public utility (e.g., urban traffic control). The benefits from the adoption of the proposed solution can be regarded as a small yet fundamental step toward a more sustainable approach to living in urban areas.**

I. Introduction

Nowadays in urban areas car parking is a time-consuming activity that substantially impacts the everyday life of citizens. Often, finding out the proper parking place asks for wondering around for an unpredictable period, wasting both time and fuel, and moreover contributing to pollution and traffic congestion. It has been recognized that sustainability in city logistics involves parking issues as well [1]; in this context an effective support to car parking becomes important in addressing the overall sustainability of urban activities.

Sensor technologies have been proposed as enabling means for effective parking management [2]: Data gathered by sensors can be conveyed via a wireless sensor network to an information management backend in charge of tracking the system state. Despite of the feasibility and the merits of this type of solutions, their actual adoption is hampered by the effort required by sensor placement. On the contrary, the broad use of mobile devices [3] opens up new perspectives, far beyond the simple support to parking payments.

In this demonstration paper, we show a mobile application for supporting wide area parking services, from search up to occupancy start/end, taking into account also reservations. The identification of any single parking spot may rely on QR codes and/or GPS positioning, reducing the system deployment costs and speeding up the automated parking procedure, fee charging included. Information on parking occupancy is kept in the system repository and used during the search phase: This way, crowdsourcing-based solutions [4] that have been previously proposed become unnecessary.

The guidance provided by a dedicated mobile application can lead to more efficient and effective car parking, with a positive impact to the quality of urban life and a reduction of fuel consumption. Moreover, the availability of real-time data on specific parking occupancies can be fruitfully exploited by other urban monitoring applications to better plan and manage traffic and public city services.

II. Parking support at work

The application helps users spot the most convenient place to park their car. The support is twofold: in real-time, it is possible searching for the closest parking location w.r.t. a given target position; for planned trips, positions available for booking can be browsed and reserved in advance. A typical parking procedure starts with a parking search action; then, as the parking place has been reached, the actual occupation is carried out by the identification of the spot to place the car on.

The system functionalities will be described from the user point of view, showing how the application has to be operated in practice. *This approach can be followed in real demonstrations as well.*

In the first place, the user is required to sign up to the system. Upon authentication through an Android smartphone, the user is then able to search for a convenient parking place within a specific area, to proceed with its occupation, and/or to book a parking spot. The automatic charging of the due fare is integrated in the overall procedure.

At any application access, some previously started procedures may be still ongoing, so the system checks for possible pending reservations or current parking occupancies, which can be dealt with by a simple management console. To initiate a new procedure, the *parking locator service* can be used to look for a convenient parking place within a specified area. To this aim, the user must provide the locator service with the city name and possibly address, and a "tolerance" radius. For example, in Figure 1a, the user is interested in the status of the parking spots in the center of Pisa, for 2 Km around. When the "Search" button is tapped, the current parking information is retrieved (through a call to a web service) and displayed on a map view. The system shows the status of the whole area (see

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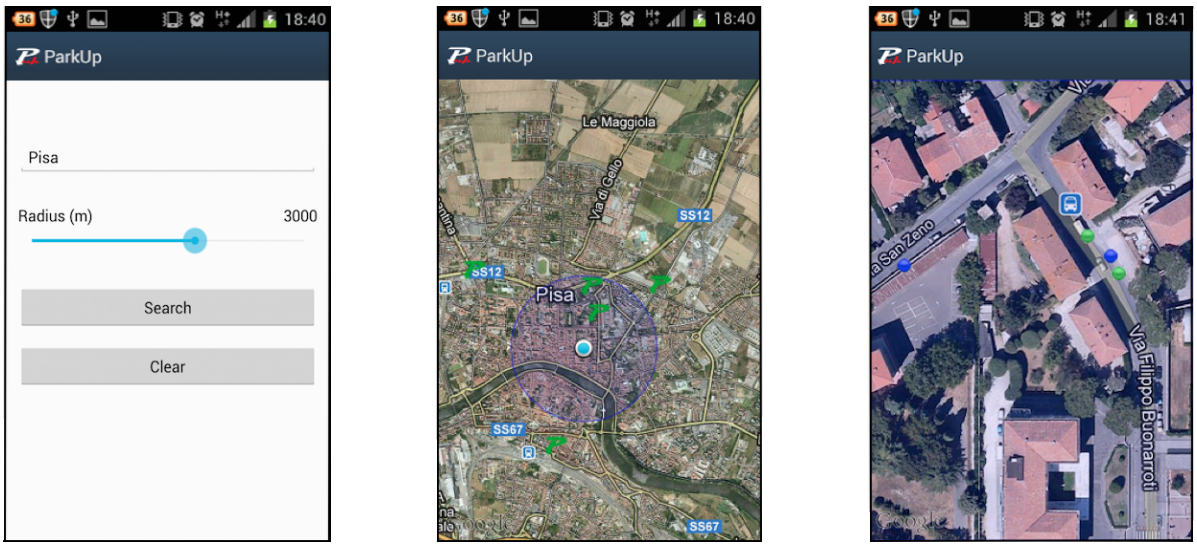


(a) Input for the locator service (b) Area view (c) Specific parking spots

Fig. 1: The screenshots show the interaction with the application to let the user find an available parking place.

Figure 1b) through different markers identified by the letter "P". The green marker means that at least one free parking spot is present in the corresponding street, while the red marker indicates that all parking slots are occupied. The user can zoom in or click on the corresponding marker in order to have a more detailed map view, as reported in Figure 1c. At this level, the application shows as many markers as the number of parking spots. Each single marker (a small dot) can take four different colors:

green:	available parking position;
blue:	available and bookable parking position;
yellow:	the parking spot already booked by another user;
red:	not available.

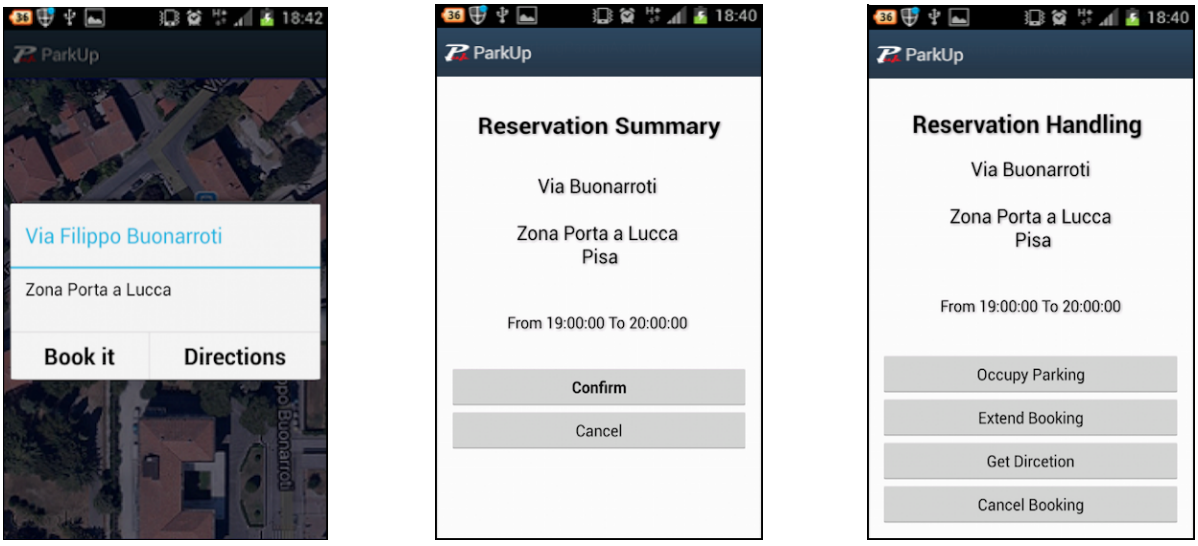
The user can then decide to head towards one specific place. Possibly, the destination can be reached making use of the satellite navigation system provided by the smartphone.

When the user reaches the place and parks the car on the target parking spot, he must perform the next procedure step, i.e. the notification of the start of the occupancy period. This can be simply done by reading the location-specific QR code placed there about (Figure 2), From that moment on, by accessing the management screen, the user is able to track information about his parking slot, such as the effective parking period and the amount to be paid so far. An explicit action is required to signal the end of the parking period, so to pass to the calculation and charging of the due fare: This can be done by a further reading of the QR code.

The system also allows for the remote booking of specific, dedicated positions. It is worth noticing that the related billing policy, as well as the ordinary one for parking, is stated by the parking manager and supported by the backend information system. When the user taps

Fig. 2: Start of parking. The related actions can be triggered by the identification of the parking spot through a QR code.

on the blue small dot marker, a popup appears (Figure 3a), giving the opportunity to make a reservation. The user must specify a parking period, and the reservation is issued upon the confirmation of the booking details (Figure 3b). Subsequently, the user can access information on the reservation through the appropriate management screen (Figure 3c), and decide to cancel the booking or extend it, for example because of the occurrence of an unexpected event. As in the previous case, it is possible



(a) Target spot selection (b) Booking confirmation (c) Reservation management

Fig. 3: Phases for selection and reservation of a given parking spot.

to get directions to the place. The actual occupation of a reserved parking spot is carried out as for ordinary parking.

A. Exploitation of QR Codes

Spatial positioning services are typically available on mobile platforms through GPS access. Anyway, this type of information may be not available, reliable, or sufficiently accurate for specific purposes: This often happens in our target scenarios. To overcome these problems, QR codes have been used to identify locations, and specifically to guide the user through an unknown setting [5].

In the described application, a QR code is used in the "parking occupation" procedure. This choice improves the application usability, and at the same time it let us collect extremely precise information on the occupation state of parking areas. Another advantage of QR codes is a cheap tagging of parking spots; the tag maintenance can be easily carried out by ticket inspectors.

QR codes placed in the open air may quickly deteriorate, and may be subject to vandalism. For these reasons, the specific code type must be chosen applying an adequate trade-off between redundancy and compactness/readability. The application software involved with QR codes is located only on the mobile clients and, just in case, other types of identification can be used to complement or temporarily substitute the basic one.

B. Implementation details

In the application development, open source software has been widely used. For the mobile part, the Android platform (ver. 4.1) has been chosen. The business logic layer is implemented as a JEE application running on the JBoss application server. The data repository consists is a PostgreSQL DBMS, whose spatial features rely on PostGIS (ISO 19125 compliant).

III. Conclusion

The application is going to be integrated into an ICT platform that will feature tools and services for innovative and sustainable mobility. The platform has being developed in the framework of the SMARTY project funded by the Tuscany Region (Italy).

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