Pedestrian Path Making: Create on Mobile and Edit on Desktop

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ABSTRACT

Collaborative mapmaking provides an opportunity for aggregating and maintaining the knowledge of convenient and enjoyable pedestrian paths into a map which visualizes them in a way that supports positive walking experience. In this work, we present two versions of a pedestrian mapmaking application, one for desktop and one for mobile use. A field experiment was conducted in which the applications were used by volunteers and their experience was inquired in order to gain insights into how they interact with each of them. The results suggested the integration of the applications into one system enabling the desirable workflow of editing of paths on the desktop application which were recorded with the mobile. Moreover, map matching recorded paths seems helpful for mobile users, reducing the need for a posteriori correction of paths. Further research could strengthen the collaboration of desktop and mobile mapmaking interfaces, as well as improve the mobile interaction for sketching paths.

CCS CONCEPTS

• **Human-centered computing** → Interaction design; Empirical studies in interaction design; Human computer interaction (HCI); Empirical studies in HCI.

KEYWORDS

Mapmaking, Mobile Interfaces, HCI, Interaction Design, Map Matching

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1 INTRODUCTION

Maps are not merely a means of conveying topographic information or a navigation tool. They have numerous ways of improving people's lives in urban environments. Although popular map applications have employed features of navigation for pedestrians, the suggested shortest routes are not always the most convenient and pleasant [15]. The information of walking paths, which provide a better walking experience, cannot be easily acquired by technical means as it concerns subjective judgements of multi-level and partly vague factors [6]. This blur can be indirectly clarified by the collective perception of city dwellers. Locals' assessments of pedestrian paths can be aggregated, forming a base layer of a subjective map where paths are visualized based on their walking experience. Collaborative mapmaking applications seem ideal for eliciting this type of subjective information from citizens or communities who share this common interest.

Collaborative mapmaking for non-cartographers, since its early steps, had taken the form of desktop applications where the interaction from the user perspective is determined by the respective interface affordances. However, the modern proliferation of mobile devices as one of the mediums of non-professional activity [9], has made many types of desktop applications to migrate to mobile apps. Mapmaking has followed the trend and some popular map editing applications (e.g. Google MyMaps and OpenStreetMap) have already taken steps to the mobile field, in an attempt to exploit mobile devices' sensory capabilities and the mobile users' generated information. Although the inherent issues in mobile interaction, such as limited interaction area and finger-to-point accuracy, have been studied and guidelines have been produced for various genres of applications [2], little has been done in the field of mapmaking. Consequently, there is not a straightforward and settled interaction design paradigm as in similar desktop applications.

Desktop applications are better candidates than mobile apps for mapmaking functionalities that require point accuracy, such as sketching geographic shapes like paths, areas of specific use, etc. [8]. On the other hand, mobile apps have the advantage of in situ examination of qualitative features. The transition of desktop mapmaking functionalities to the mobile context needs to be explored in a systematic way in order to reach the optimum user experience which will supposedly lead to greater acceptance of such applications, and ultimately to increased contributions.

The work presented here stems from the idea of creating a map which meets the specific needs of pedestrians and encourages their immersion in the urban environment through a better walking experience. Therefore, such a map could serve the promotion of walking not only as a form of beneficial physical activity, but also as a means of elevating the urban pedestrian network into a field which can improve the wellbeing of the citizens through highlighting the pleasant walking paths. Consequently, the visualization of the intended map should emphasize better walking paths, in contrast to popular base maps where, for example, the width of the roads indicates better routes for motor vehicles. This information, which is subjective, cannot be easily and inexpensively acquired by technical means. On the other hand, the collection of locals' pedestrian experiences through cartographic tools may be a viable solution to the realization of this goal. Under this reasoning, the applications presented below are designed to collect user-created

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paths, by amateur cartographers, evaluated by their perceived walking experience. The main motive of this early work towards the creation of a pedestrian map is concerned with the interaction of mapmaking tasks through desktop and mobile interfaces and can be condensed in the following research question.

RQ1: Do pedestrians prefer contributing through desktop or through mobile mapmaking applications/tools?

This paper presents a desktop and a mobile version of a mapmaking application whose purpose is the creation and evaluation of pedestrian paths for more pleasant walking and strolling. We also employ a map matching tool for improving recorded paths by users on the mobile interface.

RQ2: Is map matching considered a helpful method for mobile map contributors to improve their recorded paths before submitting them?

2 RELATED WORK

Walkability is a vague concept which is associated with many fields but can be intuitively summarized as a person's perceived experience of walking a path in an urban environment. This experience includes, among others, walking conveniences, aesthetically pleasant environment, effort of walking, sense of safety, social factors, etc. One of the key benefits of a highly walkable environment is the promotion of the walking activity, which in turn appears to have positive consequences in health and quality of life [12]. Papageorgiou et al. have concluded that citizens themselves recognize the health benefits of walking and that there is a demand for a pedestrian network app for mobile use which should provide street walkability information [14].

Interaction with map interfaces within the mobile context has been examined early on, especially with regard to map use, where the user acts as a consumer of services [13]. On the other hand, the role of the user as a producer of map data through a common smartphone on the field has been relatively neglected. However, this aspect is substantial, as users with the role of producer of information have very different needs due to the fact that they have to perform entirely different tasks. Especially, the submission of created or altered paths requires the capability of drawing high-precision shapes. There has been research which indicates that users do not prefer to draw paths in mobile devices, when mobile, among other mapmaking tasks such as recording of their paths and providing reviews [10]. However, to the best of our knowledge, there has not been a comparison of sketching and evaluating mapmaking tasks between desktop and mobile interfaces concerning user preference. It goes without saying that it is desirable for volunteered mapmaking applications to utilize the best mediums and methods to collect geographic-related information. In cases where this is done with the participation of volunteers, the preference of the users is of paramount importance.

There are frameworks which support the idea of cross-device Volunteered Geographic Information (VGI) systems, but they account of simple location information tasks that do not require map sketching [5, 16]. Moreover, there are mobile apps which can be used to contribute to popular web-based mapping services, but few of them incorporate road sketching capabilities (e.g. Vespucci). The mobile app and the desktop application presented here, both employ path sketching and evaluation for walking paths, aiming at collecting data for the creation of a pedestrian base layer map. Although the mobile app and the desktop-based application data are separated on purpose, we confirmed the user need for not just a cross-device system, but a specific workflow for creating and evaluating paths.

The use of map matching techniques in mapmaking aims at correlating and adjusting noisy recorded geographic coordinates to existing, assumed precise, geographic data. They are commonly used in mobile navigation applications to avoid setting user location out of the street network, such as on buildings [18]. Similarly, track recording has been widely used in mobile apps for providing and sharing paths, but it also has imperfections. The locations recorded are not always accurate, especially in urban environments where tall buildings affect GPS signal reception and therefore, location measurements [7]. As a result, many applications that accept recorded tracks require additional processing in order to smooth out the discrepancies and display more accurate paths [4]. There have been research projects in which tracked paths are being processed with map matching algorithms, as in [17], but the processing takes place after the submission of the paths or without the approval of the original contributor. In the mobile app presented here the users may see the map matched walking path version of their recorded path in situ and upload the one that they think better fits their course.

3 APPLICATIONS AND FEATURES

Two applications were developed, one for desktop computers and one for mobile devices. The functionalities of both the applications were kept as much as possible the same, without sacrificing their usability in each respective context. Their core functionality is the path creation which involves both sketching or recording the path, and applying subjective assessments which also affect its visualization. The evaluations concern the walkability of the path (path width) and the beauty of the landscape (path color). For example, a recorded path which has been evaluated as of excellent walkability and with very pleasing surroundings will be shown as a wide polygonal line with a positively attributed color (blue / green), while otherwise, narrow and with an emotionally negative color (orange / red). Although this paper does not discuss path visualization, the way the paths are depicted is indicative of the pedestrian network of paths which has been set as a goal. It is noted that the paths were accessible only by the application in which they were created. The creation of the pedestrian paths can be achieved per application through the different methods presented below.

Desktop application: Paths can be drawn with a polygonal chain editing tool like the ones found in similar mapmaking applications. This tool offers capabilities of point by point drawing, editing and deleting zigzagged lines. In order for the paths to be submitted, they must also be evaluated according to the users' perception of their walkability (walking experience) and landscape satisfaction (visual experience) levels from predefined scales. The design of the interface is appropriate for large screens and is based on interaction with a cursor pointing device (see figure 1). Moreover, the desktop application utilizes a "street view" approach to

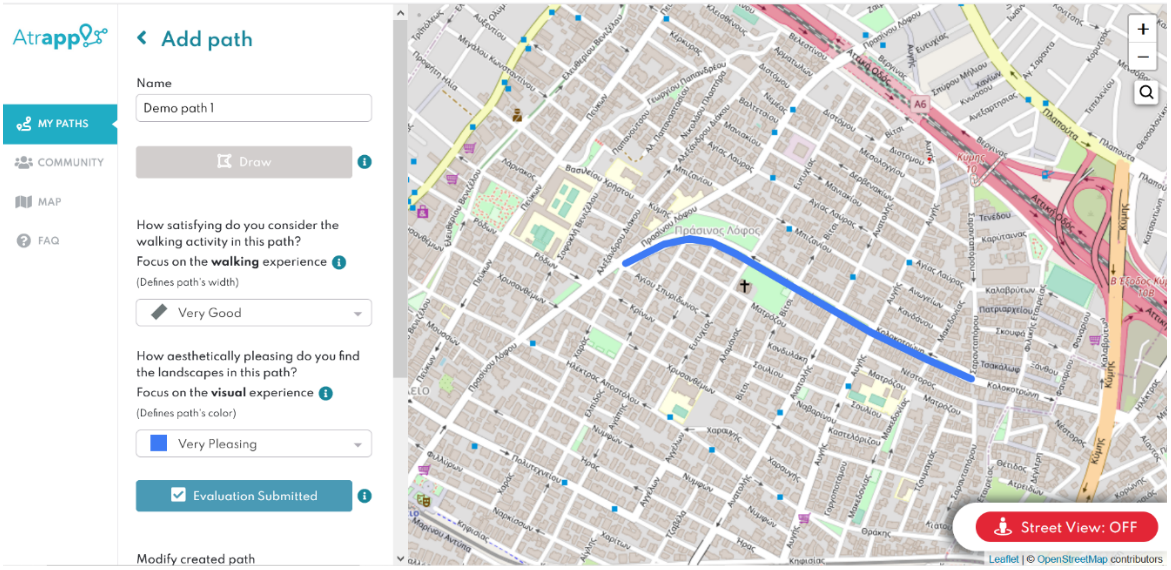

Figure 1: Path created by sketching and evaluated on the desktop interface.

let users virtually walk through the streets in order to be able to form an opinion on the evaluating characteristics of the paths.

Mobile application: There are two ways to upload a path with the mobile app. The first is very similar to the one of the desktop application. In this case the user has to use a polygonal chain editing tool, using finger gestures on the smartphone screen to manipulate the editing. Apart from the above, the flow of interaction is identical (see figure 2, right). The second method is by recording users' location as they move. Attempting to facilitate the user to contribute acceptable recorded paths, we integrated a user-enabled match-to-road service, prior to path submission, for its refinement. Usually, recorded traces from mobile devices present errors or inaccuracies in urban environments [7] and need further editing (see figure 2, left), either manually or by constructed algorithmic procedures. Recognizing that this could be a considerable reason for users to avoid uploading erroneous or unsatisfactory paths, we introduced a map matching tool. The users have the option of viewing the walking map matched (Mapbox Map Matching API) visualization of the traced path (see figure 2, middle). If they feel the proposed path is better than the recorded one, they can upload this version. In essence, it is an assisting editing service prior to submission, which we consider helps users to easily and instantly improve a path at the time of creation, while mobile in the field.

Before the experiment with the users, both applications were evaluated with a small group of three volunteers who were supervised trying the applications. They were prompted to express their experience using the applications and to report any usability or functionality issues they encountered. Afterwards, the issues that arose were assessed and those which emerged as valid and in line with the purpose of the applications, were resolved.

4 USER FEEDBACK

The field experiment consisted of the voluntary use of the applications for a specified period of 25 days, then the answer to an online questionnaire, followed by feedback from users who agreed to participate in semi-structured interviews. The design of the experiment had as a purpose to let users experiment with both applications, simulating real circumstances of urban mapmaking. Towards this, they were instructed to use both applications and contribute many and long paths in urban areas. In order for users' actions and responses to be accounted for, they should have used all available path-creating methods and responded to the questionnaire.

Due to the context of use of the applications, the participants were selected as individuals who stated that they walk a lot and expressed the desire of finding pleasant walking routes in the city via a digital map. Twenty five volunteers, most of them with an IT background, agreed to participate in the field experiment and twenty of them responded on the online questionnaire provided at the end of it. The majority of the participants (85%) belonged to the age group 26-45, while the rest (15%) to the 46-65 group. Most of them (75%) were men and 25% were women. Moreover, 35% of the volunteers had provided contributions to cartographic applications. The 25 volunteers signed up in the system, but 23 created paths and 20 responded to the questionnaire. Only 12 of the volunteers submitted paths with all the methods mentioned in section 3. From the volunteers' expressed experiences, we can gain early insights into how the different contexts affect user interaction. Below we focus on the most important results.

Here we consider 9 from the 20 questionnaire responses, taking into account only those submitted by participants who created paths using all the methods, as to ensure that the answers are based on a minimum level of familiarity with all aspects asked. As Table 1 shows, five of the respondents preferred to use the mobile application more for contributing and the other four found both of the applications equally preferable. Although it seems the mobile application is more preferable than the desktop one, it has also to be accounted for, the generic preference of personal device use. In the respective question, the respondents who stated that they

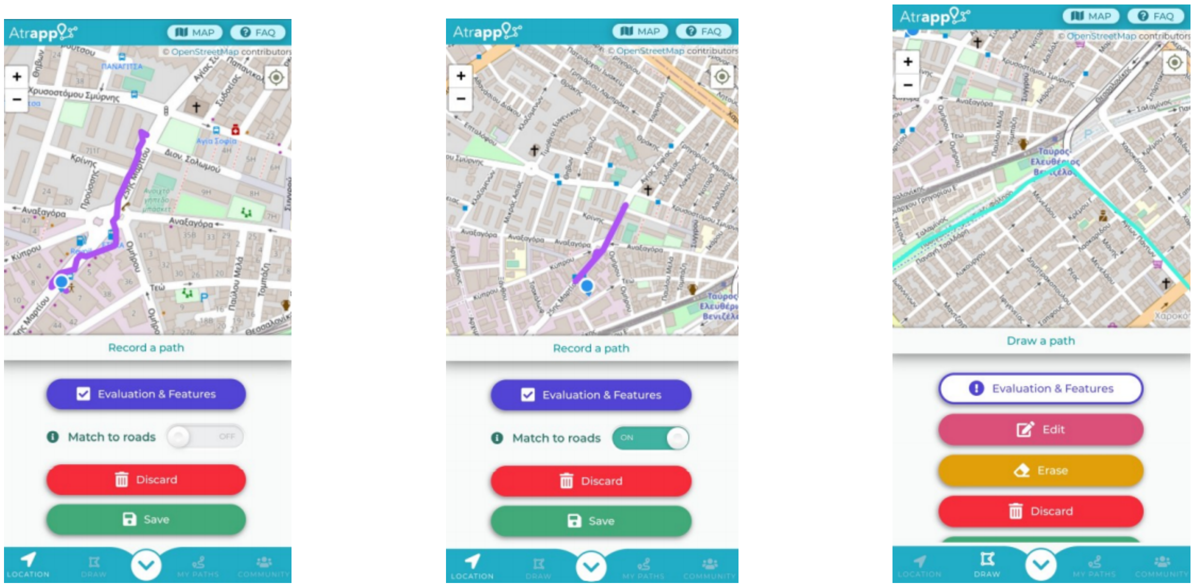

Figure 2: Paths created and evaluated on the mobile. On the left with path recording, in the middle the same path with match to roads enabled, and on the right by manual sketching.

Table 1: Application version and general device preferences.

	Desktop	**Mobile**	**Both**
Which application version do you prefer?	0	5	4
	May use	**Probably use**	**Definitely use**
Do you use your desktop computer every day? (for personal use)	1	6	2
Do you use your mobile device every day? (for personal use)	2	0	7

definitely use a smartphone daily for personal use were more (7) than those that use a desktop computer (2).

Moreover, regarding the methods used, the responses showed that three users preferred the path recording method, three found all the methods equally preferable and three chose the "other" choice. It is emphasized that the sketching of paths, in a mobile or a desktop device alone, was found more suitable for none of the respondents. The participants who selected the "other" choice expressed that a combined use of both of the interfaces for editing the same path would be more preferable.

One of the most persistent and absolute issues that the participants raised from the interviews was the complementary use of both applications as a single system. The majority commented that each application has its pros and cons and therefore, they suggested a scenario in which they would be able to record paths while walking and then edit them on the desktop interface. A relevant representative statement was as follows.

> "I would like the route I recorded from my mobile to be editable on the web application. The web application is very convenient for designing paths manually."

Additionally, interviewees expressed their dissatisfaction with the usability of the mobile sketching method. They found it difficult and unappealing. From their elaborated responses on the reasons behind this, we elicited that it is due to the small screen area of the mobile devices and the high level of zoom for the details to be visible. Users had to make continuous and consecutive panning and pointing selection gestures, making the process of path sketching a tedious interaction scheme.

On the other hand, they found the map matching tool very useful for the recorded paths. Overall, they praised it as a complementary functionality which in many circumstances makes further editing of the path unnecessary. Two of them also pointed out that there were rare occasions where the matched path was very different from the recorded and was unacceptable. They were asked about these cases and our understanding is that it was due to open areas or parks, where there were no clearly marked pedestrian routes.

5 DISCUSSION AND CONCLUSION

The relatively small percentage of volunteers who used all three methods of path-creating appears to be due to low interest in trying all the methods as there were not reported any significant issues concerning the user interfaces, besides the difficulty with the mobile sketching method. Participants' responses indicate that users prefer to use a mobile to a desktop application to contribute to path creating mapmaking tasks. Although at first sight this seemed as a straightforward inference, they also expressed their rejection towards sketching paths in the mobile application. However, we have to take into account both the interaction context and medium. An explanation of these seemingly contradictory statements could be the general preference of the mobile device as a means of free time spending, associated with entertainment, socialization, and engaging in less professional activities [1], which we also generally confirmed from the questionnaire responses. Moreover, users claimed that the specific interaction of path sketching is easier with the common input and output devices of a desktop computer. Similarly, it has been shown that some daily activities are more preferable for desktop use [3]. Nevertheless, this finding should not be an obstacle to improving the way we interact with a mobile device to create paths. On the contrary, it must be accepted that while mapmaking interaction has already been adequately developed in desktop applications, it appears to lag behind in mobile apps as we move further and further into a smartphone-centered era. In addition, the implementation of the idea of mapmaking tasks which require both drawing and subjective evaluating as a sequential and asynchronous workflow across mobile and desktop interfaces, could lead to a more usable and desirable system for users. Anyway, it is common for mobile users, depending on the task and the inconveniences they face, to complete unfinished tasks with a desktop computer [11]. One step in avoiding, to some extent, the added burden of using multiple devices, is to assist mobile users with easy path editing options. Map matching assistance seems acceptable by users as the interaction required is minimal and the results are usually satisfactory.

In this work we attempted to gain an insight into how users interact with mobile and desktop path creating/editing methods. The recording method employed, included the integration of a facilitative matching option to known walking paths. We conclude that mobile devices have much to offer in mapmaking along with the synergy of desktop interfaces, requiring a new perspective of shared workflow for higher acceptance by users. It also cannot be denied that subjective characteristics such as the walkability of paths can be better assessed in situ by users in the field, by experiencing in reality what they intend to evaluate through virtual interfaces. From this aspect, improving mobile mapmaking interaction can be leveraged for the purpose of creating a map or network of streets which will be based on walkability characteristics, which in turn will promote walking and thus, improve the quality of life and health of citizens. The above indications are based on preliminary results from a small population study with relatively homogenous characteristics and cannot be generalized. However, they provide a guide for extended studies and thorough research. We have already merged the applications into one system in which users can edit paths irrespectively of the device they were created in, but we have yet to formulate and implement a specific workflow to guide users with. The general idea is that paths recorded, or roughly sketched, in the mobile interface could be presented to the desktop interface as user's unfinished tasks for further editing. We further intend to conduct experiments with path editing methods for mobile apps, aiming at making mobile mapmaking a better and more convenient experience for users.

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