Incidental Information and Mobile Search

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ABSTRACT

There is much interest in providing effective mobile search tools. Our focus is the value of in situ sharing of users' mobile search activity. The *QnotA* prototype displays other people's queries about locations in an attempt to both provide users with an enriched sense of the places they visit, and to accommodate the limited input and output capabilities of many mobile platforms. We present the prototype and user experiences it affords. A study has been performed which allowed us to gather logged usage data and subjective participant information via diary and interview protocols. We report on findings that give insights as to the use and usefulness of the approach.

KEYWORDS

Mobile search, location, collaborative interfaces, evaluation.

1. INTRODUCTION

You are standing in bustling part of town, a bewildering range of opportunities all around you – nearby museums, great architectural sights, wonderful (and less wonderful) cafes and restaurants, a political demonstration, public transport delays. How can you – or indeed should you – get a rich sense of this place using mobile services?

One well studied approach is to provide a context-based service (e.g, [2]). This might combine knowledge of where the user is, via perhaps mobile cell-tower information or with much more fidelity, global positioning services (GPS), and their interests to deliver up careful curated detail about the location. This sort of mobile concierge ideally would prune the possibilities into a satisfying picnic of options.

The approach is attractive in principle as it removes the hard work of actively searching for information: rather, the user can browse the platter of chosen key snippets of information and web links. Services of this type have been popular on non-mobile platforms for some time. In the cell-phone or handheld context they have the added benefit of reducing the level of input required by the user, an important advantage in devices with impoverished keyboards,

and can be designed to best make use of the limited screen sizes.

However, putting aside the well-known problems of second-guessing what someone actually wants to know in a given location at a specific time, these strongly context-aware systems inherently curtail the users ability to flexibly and actively engage with the location's information space. Furthermore, the extent to which they can give a sense of the dynamically changing nature of a place and the people passing through it is questionable. Imagine, then, the morning crowds of tourists thronging Parliament Square in London, Big Ben and Westminster Abbey close-by. Then, later that day, riot-police, demonstrators, tension the place full of noise and aggression. The place is the same but the character of it has completely changed.

At the other end of the spectrum, the less pampered user could be empowered to actively seek out information. Here, of course, is the role for mobile search engines. Already, major search providers have began to offer query-style interfaces tuned to offer locally-relevant results. While current use of such services is relatively low compared to non-mobile equivalents, it is likely that search will become as "killer" an application on mobile devices as it is on the desktop. While mobile information search needs are emerging it is clear that there is already a desire in user to find out more about the places they visit via mobiles [9].

Querying offers a far greater degree of flexibility than the push-based systems. However, query approaches do require more work on the part of the user. While there have been suggestions as to how to mitigate the physical and cognitive burdens (e.g. [7, 16]), the approach will continue to require more of the user's resources than optimal in some mobile situations.

The approach we explore in this paper seeks to offer the benefits of the pre-collated and query-based methods, giving users a fast, engaging way of understanding locations. We were inspired by a radio documentary about Google. The reporter, standing in the head-quarters reception sees a large-display showing a scrolling stream-of-consciousness in the form of live queries; he was amazed, "we are looking into the mind of the world". The starting point for our work was to consider the power of presenting other people's queries about a place to mobile users.

Queries – although often short at 2-3 words –perhaps powerfully semaphore users' intentions and aspirations: "cheap hotel", "art-house cinema", "road closures". Return again, then, to Parliament Square: what sense of place would we have if we could view the queries people entered into a mobile search engine about that place? Perhaps such an approach would be better able to respond to the dynamics of the place and different natures of people passing through them.

In initial work [17], we gathered in-situ queries from a large number of people in several locations (such as museums, shopping areas and places people relax or exercise). Our analysis of the queries logged during this experiment indicated that query keywords do indeed provide clues about the nature of a place.

Here, we present a small-screen, handheld prototype that uses this type of location information. The user-experience and implementation details are given in Section 2. To gain a better understanding of the value of the approach we carried out a diary-study that provided quantitative and qualitative insights; the experiment and results are given in Section 3. We further relate our work to the existing literature in Section 4. The study has opened up a series of further questions and we discuss these and conclude in Section 5.

2. *QnotA* PROTOTYPE

The Questions Not Answers (*QnotA*) prototype provides information about a place through the lens of other people's queries relating to that location. It was developed and deployed to probe the use and usefulness of such an approach when presented via a small-screen handheld device. The prototype runs on a PDA with an added GPS and memory module (see Figure 1).

2.1 User experience

Let us consider, first, the ways the location information is presented to the user and how they can interact with the service. On initializing the application, the user is shown an aerial view of their current location. As they watch the screen, other people's queries about the place are collaged continuously (see Figure 2). The rate at which they are updated defaults to 15 seconds but the user can vary this using the control found at the bottom left of the display (from 5 seconds to 3 minutes).

Tapping on a query brings up the first ten search results for that query which are displayed in a standard scrollable list form. The user is also able to zoom-out and in to see more or less of the area surrounding the current location and can pan the display to another location entirely (see Figure 3). In both of these cases, the display is updated to show relevant queries.

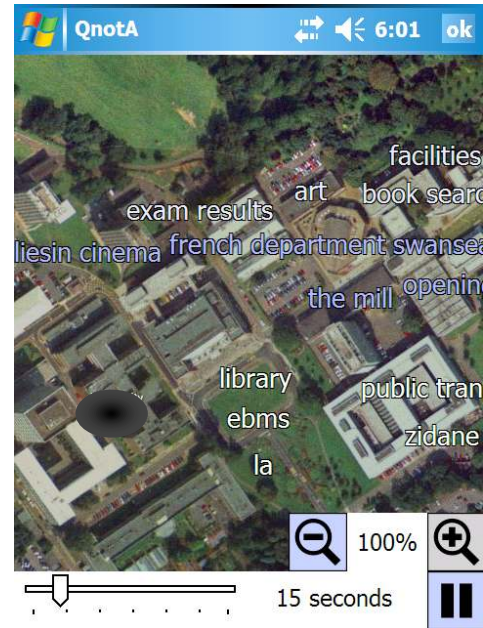**Figure 1. Prototype runs on a PDA device with GPS for location information.**

Figure 2. Screenshot of interface. Queries are collaged over location they relate to.

Figure 3. User has panned to another location. The zoom level has also been changed.

2.2 Implementation issues

The prototype runs on a PDA with a 624MHz processor and screen resolution of 480 by 640. We also use a GPS module with an integrated SD memory card (512MB). In a previous study [17], over 400 people provided queries for various locations and these are all stored on the device. The current study was carried out in the same locations, and displayed a randomly selected set of queries, specific to the current location, that were captured during the earlier experiment.

Date+Time	Location**	Sense of place rating*	Useful queries	Intriguing queries	Distracting queries	Queries you would add	Mental effort rating*	Frustration rating*	Enjoyment rating*
Sunday 13:20	Train Station	1234567	Biking coffee	pollution	motorcycle mot wedding dress	bus & train links taxi companies	1234567	1234567	1234567
Sunday 14:00	Seafront	1234567	hotels tearooms	where can I hire a bike? Angel chambers	Steelmaking	bike path info Sunset Sunrise?	1234567	1234567	1234567
Sunday		1234567	Properties	lighthouse	Dexters	Restaurants	1234567	1234567	1234567

Figure 4. Example extract from a participant's diary.

Both the aerial views and search results are provided by the MSN Live service (www.live.com) through the standard API. The ten results per query are all cached on the device so that no internet connectivity is required. While it is trivial to enable a 'live' search, we wanted to control for network and search engine effects so that all participants in the study had access to the same query and result sets.

As with all proof-of-concept prototypes, it is important to consider how feasible it would be to scale-up the service to widespread use. The key element is the query data. The approach assumes that there will be a ready supply of location-based queries that can be shown to other users. We will consider the privacy aspects later, and solely address the technical issues, here.

Queries relating to a place might be generated in two ways: first, someone in the location might be using a mobile search engine, entering a query; secondly, the remote case, someone might enter a query that maps to a web resource about the location.

In the first case, the mobile query can be tagged with location data using either cell-tower information or if the device has a GPS unit (as many mobile handsets will in the next several years) using satellite positioning. In the second case, a number of techniques are emerging to identify the place a web resource refers to – these range from postal address processing to more sophisticated text mining techniques.

3. DIARY STUDY

Diary studies have been widely employed in mobile HCI research (e.g. [4]). They provide an effective way to monitor use and impressions over extended periods of time. The study took place over four weeks with groups of people taking part in the study each week for a period of four and a half days.

3.1 Method

3.1.1 Participants

Eleven participants were recruited from a pool of 100 people who responded to our request for volunteers. All of the participants were members of a university; humanities and science subjects were equally represented in the sample. The selected people ranged in age from 18 to 35 and were all regular search engine users and mobile phone owners. The participants were put into 4 groups (3 groups of 3 people; one group of 2 participants).

All the participants were resident in the city where the study was located.

3.1.2 Apparatus

Each participant was lent a PDA with the service as described in Section 2. The device automatically logged all interaction with the system, including dates/times/locations of use, form of interaction (e.g. query clicks, zooming etc).

Participants were also given a diary log-book which we asked them to complete after each time they used the prototype. The fields they were asked to fill-in for each entry were:

- Date & time of entry (e.g., Thursday 5pm)
- Location (e.g. campus)
- Degree to which the queries gave a sense of the location (from 1 – low – to 7, high)
- Queries they thought were useful
- Queries they thought were intriguing
- Queries they thought distracting
- Queries they would add to the ones they saw
- Interface mental effort rating (on a scale of 1 – low – to 7 – high)
- Interface frustration level rating (on a scale of 1-7)
- Interface enjoyment rating (on a scale of 1-7)

The last three items of each entry aimed at eliciting 'task load' style data [5]. An example set of diary entries is shown in Fig. 4.

3.1.3 Training

Each group of participants met with a researcher on the first day of the trial (a Thursday). They were each given a device and the purpose of the service was explained to them. They were given time to explore the interface and to ask any questions they had. The diary log-book and other forms of data capture which the experiment required were explained to them.

3.1.4 Procedure

After the training session, participants were asked to use the prototype at least once during the first day (Thursday) and then at least three times on the following four days (Friday-Monday, inclusive). Weekdays and weekends were chosen to increase the likelihood that participants would find themselves in a range of locations (e.g. campus, shopping areas, seafront). We asked them to attempt to visit several such locations during the trial.

On day two of the trial (Friday) a researcher telephoned each participant to discuss their initial impressions and to resolve any technical problems. After the trial (on Tuesday) each participant was interviewed individually for approximately half an hour. Their diary entries were discussed and wider issues considered.

3.1.5 Analysis

After all four groups of participants had completed the study, the logged interaction data was analysed; quantitative analyses were also carried out of the diary data. Diaries were also studied along with the interview transcripts to garner qualitative insights.

3.2 Quantitative Results

3.2.1 Usage Patterns

Our participants used the full range of interactions available in the navigator application. Zooming was a regular occurrence, with there being an average of 1.6 zooming actions (in or out) per session. Zooming out was more common, accounting for 65% of all zooms. Conversely, users were more likely to slow down the rate at which the displayed queries were refreshed, with an average 1.86 "slow down" actions per session, in contrast to an average of 1.06 "speed up" actions. The total number of clicked queries per session was 3.27, with a high standard deviation of 3.77. The highest number of clicked queries per session was 18.

Over the four days of use, the average time spent using the system by a user was 2 hours 41 minutes. In total 178 sessions were logged.

3.2.2 Selected Queries

The most popular clicked queries were: "pubs", "zidane" (8 participants), "William gammon", "French department PLACE[1] uni", "post office" (7 participants), "canopic jars", "cinema", "PLACE metro" "xbox 360", "cinema PLACE" (6 participants). There is clearly some overlap between these queries (e.g. "cinema" and "cinema PLACE"). The frequency of a query being clicked on and its subsequent rating by the participant varied.

3.2.3 Subjective Query Ratings

Our participants were asked to rate the stored queries that were displayed to them during each session. In each case, subjective responses were written in their diaries where participants listed queries that they judged *useful*, *distracting* or *intriguing*. They were not obliged to write a judgment for all the example queries displayed to them, so some queries will not have been labeled at all. We now review the subjective feedback obtained from our participants.

Participants found many queries useful; the total number of unique stored queries that were found to be useful by at least one participant was 57, and on average a specific query was judged as "useful" by two participants during one or more sessions.

Individual queries may appear more often than others. Some, having been entered by a number of different participants in our first study, would occur proportionately more frequently in the QnotA browser interface. Furthermore, some sites were visited by more of our participants than others. For instance all 11 visited both the city centre and the university campus whereas the PLACE Centre received only two visits. Subsequently, we can expect the classic "power law" or Zipf distribution frequently cited in research literature [1] upon information seeking to recur. This is certainly the case, with 29 of the 57 unique queries being rated as useful by only one participant each.

Out of the queries rated as "useful" the most popular were: "post office" (9 participants) "bus times", "books" (6 participants each)

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[1] Name removed for anonymity purposes in review.

"bank", "Taliesin", "museum", "restaurants", "library opening hours" (5 participants each), "Waterstones", "spar" (4 participants each). A comparison with the selected queries (in 3.2.2) reveals that many commonly clicked items were not judged as being useful in the diaries. The correlation between clicks on queries and "useful" ratings was 0.34.

Further exploration of the data reveals that curiosity played a bigger part in the clicking of search terms to reveal their result list. This is clarified if we subsequently look at the top queries that were listed as "intriguing": "*PLACE* Metro", "Metro roadworks Kingsway", "Zidane", "photographic exhibition" (4 participants each), "*PLACE* cinema" "art gallery", "canopic jars", "lighthouse", "tide tables" (3 participants each). The Zipf distribution seen in the useful ratings is seen again in the intriguing ratings. The correlation between "intriguing" judgments and the number of clicks on a query was 0.49.

A final review of the items listed as distracting gives a further perspective: "wedding dress" (6), "betfred", "xbox360", "zidane" "dexters" (5) "*PLACE* metro", "william gammon", "sa3 4ae", (4), "canopic jars" "Ibiza" (3). Some items appear as often in the intriguing as the distracting list (e.g. "Zidane"). Again, the correlation between click rates and "distracting" judgments is stronger than that for the "useful" rating: i.e. 0.45. In some cases, users would report a query as both intriguing and distracting – this happened twice, for instance, in the case of "william gammon".

It thus appears that exploration of the interface seems driven by senses other than the utility of the queries. For example, the query "pub" was universally rated "useful" but only clicked on eight times across all sessions by all participants. This was a query that appeared in four different locations and had been entered multiple times in the original study – so it was a commonly displayed term, and rated useful during 38 separate sessions. This contrasts with the "photographic exhibition" query that was recorded only once during our original study, and subsequently appeared infrequently during this experiment; none-the-less it was clicked on five times and reported as intriguing in four participant's diaries.

Finally, it might be expected that participant's use of or response to the system varied over their exposure to the system. A careful analysis of the data shows no statistically significant variation to the subjective responses; average ratings of "sense of place" rise slightly day-to-day from 4.18 to 4.59, whilst "mental effort" and other measures vary by a smaller range (within a 5% variance) and no overall direction. Even the apparent progression of sense of place may simply be a spurious artefact. Conversely, we can readily dismiss any hypothesis that there was falling enjoyment and rising frustration across the period.

3.2.4 Participant's Suggested Queries

Participants were asked to add further queries in their diaries that they felt were relevant to the given location. A total of 58 unique suggestions were made, of which 31 were literal repetitions of stored queries from the original study. Common suggestions were "train" (5 participants), "restaurant" and "pub" "museum" and "boat hire" (3 participants). Other items received a recommendation by only two or fewer participants. No novel recommendation was made by more than one participant. The *QnotA* prototype thus seems to have made a significant impact on the vocabulary used by our participants when describing the same or other places. This leads to two possible hypotheses: either the system is successfully capturing much of the essence of places, or it is influencing the users' vocabulary.

3.2.5 Sense of Place

The sense of place created by the displayed queries was relatively neutral overall; given the nature of some of the locations (e.g. a town centre, a shopping mall) this was unsurprising. The average score was 4.38 with a standard deviation of 1.75. However, a different picture emerges when the responses are viewed by location. The shopping mall was a common location in the searches, and the mean sense of place score was a mere 3.85, with a standard deviation of 0.69; in other words, this location had a much closer agreement on the sense of place, and the sense was relatively weak. In comparison, the average score for the university campus was 5.02, though with a higher standard deviation at 1.82.

The study covered over twenty sites, of different purposes and styles. For instance, the sites included three museums, two residential areas and two retail locations, a university campus, coastal area, etc. The retail and residential locations scored lower for sense of place, whereas heritage locations scored highly. There was a statistically significant difference, for instance, between the shopping mall and university (p=0.05). The small number of visits to some sites prevents a comprehensive site-by-site comparison. However, if significance is tested for between the type of locations (e.g. coastal locations versus retail areas) the results are clear, with coastal sites receiving an average of 5.04 versus a retail average of 4.03, and the difference being significant (p=0.05).

Individual sessions, even for one user, could vary considerably at the same location in terms of the experienced sense of place: for example, the same user experienced one session they judged a 5 (out of 7) and another of 1 on the university campus on the same day. The system's simple presentation, selecting from all queries in the database, meant that this sort of variation was likely. However, even though some stored queries were common to a number of locations ("coffee shop" being one such example), we nonetheless saw an overall effect from place.

It should, finally, be noted that the perceived relevance of a search to a location may not be identified by the participants. We already noted above the differing responses to "*PLACE* metro" with two participants clearly not knowing what this represented. Likewise, at a coastal location there was apparent confusion over a "valley line" query. It is well known locally that a tramline ran at this location, with modern day signage and summer activities related to it. However it is probably not so well known, and not marked publicly, that a railway called the "valley line" also ran through the same location. Both lines now form footpaths, but one is a common commuter route for cyclists and pedestrians that runs alongside a major road, the other is a recreational route accessed from the woods at the back of a small car park.

The "valley line" is, therefore, certainly representative of the location, yet three participants found the query "valley line" distracting and only one rated it "useful". Without pointed questioning of our participants, we cannot be certain of their knowledge of the route, but their response suggests that it is generally low. Notably, the "distracting" raters did not follow the query to investigate the corresponding list of matching documents.

3.2.6 Subjective Measurements

In addition to sense of place, we also probed the users' experiences in terms of mental effort, frustration and enjoyment. The mean score for mental effort was low – only 2.43, with a standard deviation of only 1.03 across all interactions. Frustration levels were also generally low, at a mean of 2.58. However, some difficulties with the hardware (e.g. failure to achieve a reliable GPS signal) contributed to a number of higher scores for this measurement, according to the participants' diaries. Finally, perceived enjoyment averaged 4.22, with a deviation of 1.29. This relatively neutral score showed a considerable degree of variation by place, though not as marked as was the case with perceived sense of place. One may expect that there was a correlation between perceived sense of place and the participant's enjoyment. However, no such statistical correlation could be detected. Indeed, the highest ratings of enjoyment occurred in the place with the lowest scores for sense of place – a residential area.

3.2.7 Interaction pace and time

One potential facet of the browsing style of interaction that the *QnotA* prototype was built around was a low-speed, "laid-back" pace of interaction. The interface is not focused on high-precision, high-focus information seeking; rather it hopes to support opportunistic discovery and serendipitous findings. However, would our users actually behave in a "laid back" manner, or attempt to use the interface in a more focused, drill-down manner?

Out of a total of 178 separate sessions, 18 were 10 second or more sessions in which no interaction occurred. It would thus appear that a low-attention, low-speed interaction played some part in the system's use. This pattern uncovers further as one looks within sessions; within the first minute of a prolonged session, on average there was only one interaction (e.g. zooming, clicking on a query). This suggests a period in which the user is primarily viewing the screen content. As the *QnotA* system by default changed the screen display six times in this period, replacing all the displayed queries each time, this seems to reflect a period of observation. After this first minute, the interaction speeds up, with a rate of between 2.4 and 4.0 interactions on average across the next nineteen minutes. Activity rate accelerates from the first minute until the third, and then continues at an average rate of 3.21 actions per minute, varying as already described.

Most sessions were brief – only 61 sessions (34%) extending beyond the eighth minute, and 15 (8.4%) were active after 20 minutes; conversely, only 44 (24.8%) sessions lasted less than four minutes. The longest session remained active for 34 minutes.

3.3 Qualitative Findings

Our participants participated in a post-study interview to elicit their response to the *QnotA* prototype. This section will summarise the key findings from this part of our experiment.

Participants reported disappointment at not being able to input their own, new searches, and also at only being able to retrieve the pre-fetched search results. As noted above, this restriction was partially due to the variable reliability of access, and in part due to our own interest in ensuring direct comparability between sessions and participants.

The heterogeneous nature of the searches input by our original set of 400 human searchers led to some confusion. Participants were perplexed by particular searches – e.g. one for "yellow goods" – but nonetheless noted that some searches were useful, or interesting. One particular problem was queries that were clearly not related to the area where they appeared. The *QnotA* prototype did no checking that a query was specifically related to the

location where it originated, nor any other post-processing. One example that was identified by a participant was a set of searches in a residential area for a specific cinema, which is located at the other side of the city. Though quite naturally it may be a search performed anywhere in the town, it is logically targeted at a building in one specific place. Relatively simple techniques could be deployed to reduce the number of incidences of this particular problem.

Nine participants volunteered some unexpected information that they had discovered whilst using the system. Given the brief four-day use that they had of the system, and the limitations of access just addressed, the *QnotA* prototype demonstrably added to their knowledge of an already familiar location.

The diaries also revealed a number of important details. For example, one participant found the stored query "*PLACE* metro" intriguing, and underneath it wrote "so now I know what it is!". This is just one example of a number of moments of discovery that were reported in the diaries. The playful nature of the interface hinted at in the user's rating and click-through activity continues to be reinforced by an examination of the narrative parts of the user diaries. However, not all uncertainty resulted in exploration. Another user responded to the same query by labeling it "distracting" and subsequently writing underneath that rating "No idea what it is".

GPS reception naturally varies over any area, and we had a considerable number of complaints regarding the performance of GPS – participants frequently having to resort to manually identify their location. We do not have sufficient data from our logs to identify the number of times that this occurred, but our user's diaries highlighted that this was a significant contribution to their frustration with the system. One participant only got GPS to work on one occasion, and although they provided positive feedback about the system, they admitted a considerable frustration with the GPS problems.

A number of minor improvements for the system were suggested, including the categorization of queries through colour coding, and also ensuring that queries were sufficiently distant from each other to ensure that two queries did not appear next to each other and appear to be one. Another common suggestion was to relate queries that targeted a specific location (e.g. "*PLACE* Castle") to the exact location on the map, rather than a less clearly defined area.

3.4 Discussion

The study revealed a number of unexpected patterns in user behaviour. As we noted above, click-through rates are more strongly correlated with a user rating of "intriguing" or "distracting", and suggest that our participants engaged with the *QnotA* prototype as an exploratory and playful environment. This is echoed in the qualitative data gleaned during the post-study interviews, where participants described enjoying their exploration of the environment.

Unexpected findings are not always appreciated at first sight – as we saw in Section 3.3 where one participant discovered new information whilst another dismissed the same search without exploring it.

Context aware systems respond to the challenge of user's variations in taste or interest by building profiles to select the appropriate information. However, none of our users expressed a particular ongoing interest in public transport during the interviews or elsewhere. Transport related links such as "bus timetables" were labeled "useful" by seven participants, but seldom clicked on (three participants). Likewise "William Gammon" was explored by eight participants and seems unrelated to the profile you would expect of our panel. Therefore our contrasting approach, that simply brings to the surface information seeking activity in a place, reveals material that it is hard to foresee being targeted to our participants by any selective profiling system. The Zipfian distribution seen in our experiment, and in other information seeking studies, naturally means that much of the "long tail" is related to little other material. Hence, intelligently selecting the right parts of the long tail are hard, particularly if surprise is important. Choosing another book by the same author, or on a similar topic on (say) Amazon is both rational and functional. However, any connection between (say) coal mining and an Egyptian museum is clearly tenuous, or conjecturing interest about awareness of, or interest in, a farming and country event from other preferences is fraught with difficulty. What may be an appropriate one-off distraction for an afternoon may be very different from ongoing interests. Clearly, there is a need for selected, targeted information that a context-aware approach can supply. However, using that approach alone would eliminate the discoveries made by our users.

The contrast between our participant's functional rating of a linked query and their actual behaviour in the *QnotA* prototype suggests that a distinction could or should be made between functional information about a place – "café", "bus timetable" or otherwise – and less familiar topics such as "Canopic jars" or "tide tables". In short, supplementing more traditional, focused information services with the ludic, playful information that our users more frequently explored will provide a wider opportunity for discovery. Conversely, eliminating or distinguishing more functional information from playful, randomized data would provide scope for the *QnotA* prototype to focus on the novel, game-like aspects of the system. Our participants also suggested using colour not only to distinguish between individual searches, but also to impart particular meaning to a search – e.g. colouring queries by category.

The moderate rating of sense of place reported above may seem to be a negative outcome, however we have no benchmark against which to measure this value. It is quite possible, indeed probable, that lower ratings would be achieved by alternatives such as randomly assigning any tag during a session, rather than only queries performed at that location.

As we observed in Sec. 3.2.5, users may not be aware of features of or facts about their local environment, even a familiar one. All our participants were resident in the place where the study was conducted, yet the majority noted a discovery of something through our prototype. In a less familiar environment, it can reasonably be conjectured that the opportunity to find unfamiliar or unexpected information would be higher.

What is clear from our data is that certain sites such as retail centres provide little sense of place, whereas heritage and recreational sites provide a stronger note that is reflected in the interface. In short, the system can reflect a distinctive character for, say, a museum, but a venue outside a coffee-shop chain with a nearby high-street music retailer and a national electronics store is unlikely to produce much sense of character. We can reflect character, but not produce it.

The *QnotA* prototype demonstrates that a opportunistic and playful mode of information discovery can be enjoyable and useful. Providing a supplementary approach to the focused methods of context aware recommendation allows for the identification of unknown and unexpected items of interest. A sense of place can be garnered from queries made in a location of character, and without the intervention of sophisticated information retrieval or data mining techniques.

4. RELATED WORK

Kaasinen [10] carried out an extensive set of investigations to uncover user needs for location aware services. In content terms, some of the findings support the design rationale of the *QnotA* prototype and resonate with the feedback we received from our participants. Participants indicated the need for timely, topical information that reflected the changing context. There was also a desire for user-generated localized content so that visitors to a location could benefit from other people's experience of the place. The study also considered the level of interaction users might wish for: in some mobile cases, a minimal style is important but in other cases, users might be willing to engage more actively to find out particular information.

Our current prototype focuses on reducing the degree of interaction required: they view the continuously updated collage of queries and if wished can explore the search results these queries lead to. This reduced interaction can support glance-based interaction. It is easy to envisage the *QnotA* service running as a background, 'screensaver' style service on a mobile handset and users glancing to get quick insights into interesting places, services and events in their vicinity.

This 'at-a-glance' style has been seen in several earlier pieces of work. For example, in [13] the focus is watch-based services such as a weather forecast and stock-market information; information viewed with a quick wrist flick. Another, quite different clock, the 'Whereabouts Clock' uses the last reported position of mobile group members to provide an at-a-glance visualization of their location [15]. Finally, [11] addresses designs for in-vehicle visual interfaces to reduce the number of glances needed to take in salient aspects.

In the prototype, queries are used as very concise pointers to location relevant content. Much research has shown the value of providing summary information on small screen devices, reducing the need for users to navigate large information spaces, a process that can be frustrating and error prone. In [7] for instance, keyphrases are extracted from web documents and are used to characterize their content. In an experiment these surrogates were found to be as effective as the document titles. A similar approach is used in a text-message based search service [16]: instead of returning result lists, text-mining is used in an attempt to provide a direct answer to a user's query (e.g., "pizza 10013" returns the telephone number of a restaurant in that zip code area).

The queries are also acting as user-generated tags for the location. GeoNotes is an early example of a system that allows users to place digital content in the physical world for others to access later [11]. The MobiTip system [13] provides ways for mobile phone users to share opinions, recommendations and other information within both physical locations and social spaces. Bluetooth hotspots in specific locations are used to collect the shareable content and user's own devices are able to connect in an ad-hoc way as people come into close proximity with each other.

HyCon is an ambitious system that allows users to share the results of their in-situ browsing and searching, creating location-based link sets, guided tours that draws on web material and annotations [6].

These systems, and many others in the augmented reality literature, rely on people explicitly authoring content for physical places. In contrast the *QnotA* prototype tags locations as a side-effect of another form of interaction, search. That is, users implicitly contribute content; they generate incidental information.

5. CONCLUSIONS & FUTURE WORK

The *QnotA* prototype gave participants a clearer sense of place in locations that had queries that were distinct rather than generic. Other people's queries about shopping areas – "coffee shops", "pubs" etc. – are unlikely to significantly enrich one's understanding of the area. In contrast, queries emanating from a museum area – "death poem", "laughrne" etc – have the potential to provide non-obvious insights.

Participants most often clicked queries that were also rated in diaries as 'intriguing' or 'distracting'. Again, this behaviour suggests the value of the approach is in making known perspectives on a place that are different from one's own. As other search literature shows (e.g. [9]), the diversity in user populations is reflected the wide variability in queries; and as we posited earlier, although often short, these queries might encapsulate succinctly values and attitudes.

All participants actively used the interface by clicking previous queries. However, around ten percent of sessions involved no such interaction and in every other session, on average the first minute contained just one interface event. The prototype's glance-based style was being exploited, participants watching the changing collage of queries to orient themselves to the information available before making choices, if at all. Many mobile applications are task-focused and require the user to actively engage. Perhaps more effort in the research community could be put towards considering more slower-paced, ambient interfaces and interactions [8].

Clearly, a key purpose of the study was to ascertain the usefulness of the novel approach. The logged data, diary ratings and interviews all suggest that the method would be valued as an additional location-based service. Its power may not be in providing answers to utility needs (e.g., "I want a bus timetable so I can get home") but to fill the wish to highlight the hidden, unusual aspects of a location. There is much work that might be done here in filtering, clustering and visualizing the stream of queries. Allowing the user to dynamically alter the categories of queries presented (e.g., based on popularity or uniqueness) using a technique such as the Starfield visualiser [3] might be effective.

The work has opened up questions about the spectrums of content (serendipitous-to-curated) and the styles of interaction (browse-to-search) in mobile location-based services. We have already outlined the sorts of uses the *QnotA* information type and interaction style might afford. There is work to be done, though, on further understanding how the sorts of approach outlined in the introduction might work together in complementary ways.

6. ACKNOWLEDGMENTS

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