The Gopher Game: A Social, Mobile, Locative Game with User Generated Content and Peer Review

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ABSTRACT
This paper introduces 'Gophers', a social game for mobile devices that utilises task oriented gameplay to create a novel entertainment experience. The study combines a number of key research themes: mobile social gaming, acquiring useful data through gameplay and content sharing in mobile settings. The experience of trialling the game in the real world is discussed and the findings from the study are presented.

Categories and Subject Descriptors
H.5.3 [**Information Interfaces and Presentation**]: Group and Organisation Interfaces – *computer-supported cooperative work.* I.2.6 [**Artificial Intelligence**]: Learning – *knowledge acquisition.* K.8.0 [**Computing Milieux**]: Personal Computing – *games.*

General Terms
Human Factors, Design, Experimentation.

Keywords
User-Generated Content, Social Networking, Locative and Mobile Gaming, Context Acquisition, GSM Cell Phones.

1. INTRODUCTION
The adoption of mobile phones in recent years has brought society to the point where mobile computing technology is in the hands of the masses. Potential applications for this ubiquitous connectivity are only just beginning to be explored, and one promising area of investigation is the field of pervasive gaming. These experimental games are designed to examine how the emerging capabilities on offer could be practically used in the real world. Mobile social games represent a subset of this genre and utilise the interactions made between players and their relationship with the physical world to provide an entertaining experience, while at the same time revealing how users socially interact when using the devices. The Gopher Game has been designed with a number of current research themes in mind:

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1.1 Theme 1: Mobile Social Gaming
The Hitchers framework [3] was developed at the University of Nottingham's Mixed Reality Lab for use as a social gaming platform. It exploits readily available location data provided by the GSM cell phone infrastructure, to create a digital hitchhiking experience. It aims to act as an extensible framework from which to develop future location aware cell phone games. This framework was used as a base to develop the pervasive game 'Gophers', described in this paper.

1.2 Theme 2: Useful Data from Games
The use of gameplay for gathering information has recently been employed by several popular games (notably the ESP game [12] and Peekaboom [13]). These studies are based upon online casual games and make use of human responses to label databases of images. The release of Google's *Image Labeler* [5] further extended the popularity of this concept. The Gopher game is designed to produce geospatial labelling information from player interaction with a view to using this in later locative applications.

1.3 Theme 3: Mobile Content Sharing
With the advent of Web2.0, user generated content is shared in an increasing number of ways. Contextual updates are sent through SMS/MMS messages and individuals blog their daily lives, sharing personal photos and videos with the rest of the world. Such content is becoming ever more popular on the Internet, with the convergence of mobile, blogging and geolocational technologies. The Gopher Game makes use of this information by incorporating automatically created blogs (that record game activity) into the gameplay.

1.4 Introducing Gophers
Gophers is a locative game developed for Nokia Series 60 camera phones. It combines user content sharing and pervasive task-driven gameplay, to create an enticing social gaming experience.

Gophers are in-game agents that act as carriers for tasks and proxies to carry information from one player to another. The nature of a task is completely open-ended and predetermined by the player who created the gopher. As they move around their physical surroundings, players encounter new gophers. If any gophers of interest are found, a player can pick them up using their phone. Once acquired, a player can help a gopher complete its mission by interacting with it through the supplying of camera phone images and textual content. With each interaction, gophers

collect situated content [10] that is used to generate an evolving narrative relating to their game tasks.

Once a gopher is acquired, it resides on the player's phone and is visualised in their list of current gophers. While present on the phone, it is not discoverable by other players. A gopher remains on a phone until the player decides to drop it, or it becomes bored and leaves of its own accord. When dropped, the gopher remains at the current physical location, (defined by the identifier of the nearest cell phone mast), and stays there, in a dormant state, until being picked up by another player.

Tasks often require the cooperation of numerous players. When a gopher has completed its task, a player can submit it for trial by jury. Here, the gaming community judges whether the mission was a success by reviewing the blog information. After the trial is complete, the gopher is returned to the player who originally created it. This player is then able to assign the gopher a new task and re-release it, or retire the gopher and thus, remove it from the game.

A player's performance in the game is dictated using points (with more points being better) and these are displayed on a web-based leaderboard. The points also act as the in-game currency and can be invested by the player to participate in the game's activities (for example, creating a new gopher, or participating in the guessing game, cost a certain number of points).

1.5 Research Aims

The studies conducted using the game explore the collection of semantic information about the physical world, as a by-product of gameplay (through the collection of geospatially and temporally tagged photographs, text and keywords). The investigations also look at the use of pervasive, task-based play in creating exciting, non-linear gaming experiences. In the game, user-generated situated content is collected by the game agents (gophers) and delivered to other players. An additional research aim is to make use of this content to promote mobile 'information encounters' [2], with players being presented with situated information as they play the game, explore and make use of their environment and its attributes.

2. PLAYER EXPERIENCE

The player received two distinct modal experiences of the game world: the mobile mode and the web mode. Mixed reality studies such as *Uncle Roy All Around You*, show that it is possible to combine these experiences in a carefully designed game [4]. Figures 1 and 2 illustrate an overview of the game from a real world perspective; Figure 3 shows a "web's eye" view.

3. TECHNICAL IMPLEMENTATION

The following are the key technical areas considered during design and development of Gophers:

3.1 Mapping Location to Gameplay

In many pervasive games, physical location is used to directly map a player's location onto the game world (for example, the player's position in CatchBob! [8]). Gophers took a different approach by using location data as an indirect aspect of the gameplay. This allowed the effects of the inherent instability and errors associated with positioning systems to be ameliorated. Cell ids were used to locate gophers, content and events that had occurred in the game world. Gophers could be assigned localised missions, for example, that could only be completed at a

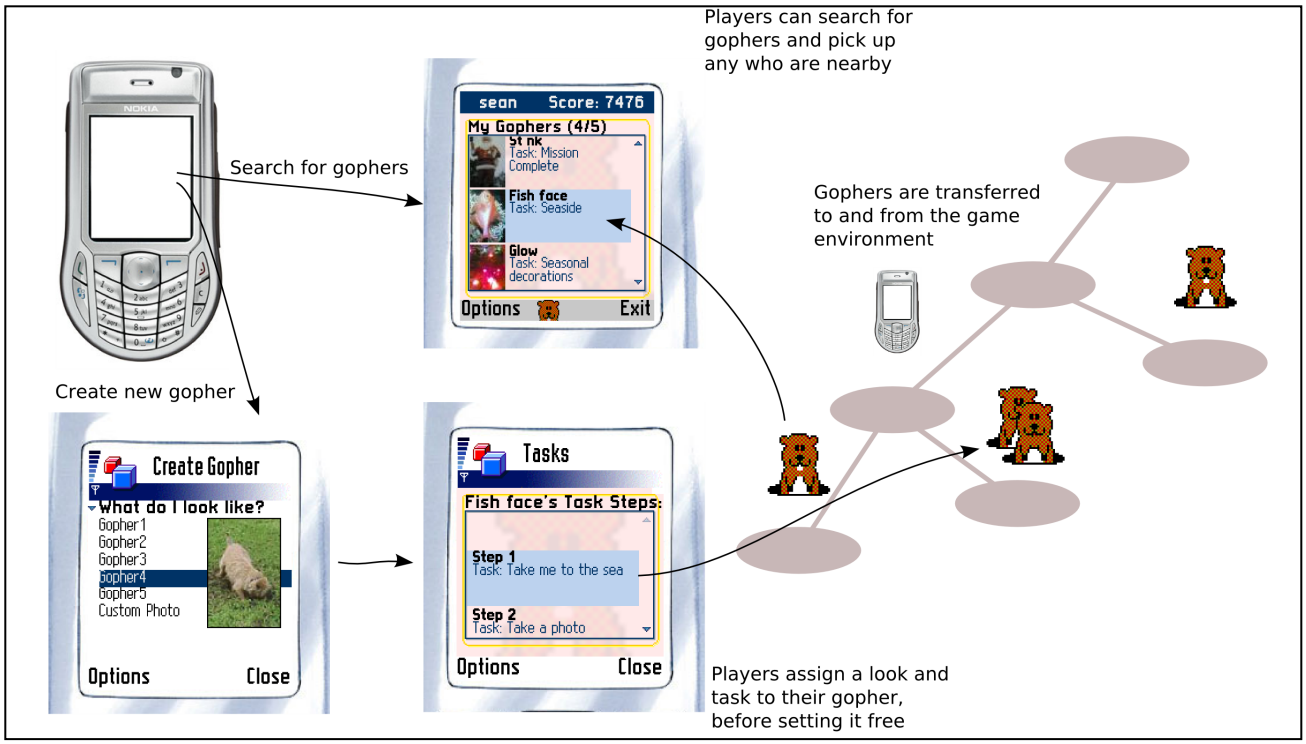


Figure 1. Real world experience, acquiring gophers

particular place. Because of the intrinsic link between many gopher tasks and the area in which they are found, players were encouraged to pick up nearby gophers as opposed to those further away. In early iterations of the game, only gophers within a player's current cell were discoverable. This was playable when tested locally with a number of highly motivated players, but in an environment that was not densely populated with players and gophers it presented a less rewarding experience. If searches regularly returned no gophers, players simply stopped participating. A revised search mechanism that encouraged players to pick up nearby gophers, yet scaled between sparse and densely populated gaming communities was implemented, using a node graph based on the connections between cells. Each vertex, or *node* on this graph represented a mobile cell mast with edges connecting masts that were physically adjacent. When a player searched for gophers, the game returned a distance ordered list of the nearest 16 gophers. This distance was calculated using the network distance between the player and the gopher (calculated using Dijkstra's algorithm). When a gopher was in the player's current cell it could be picked up immediately, otherwise the time it took the gopher to arrive at the player's phone was proportional to the network distance (10 minutes per hop). Players also paid an additional transportation fee (equal to the number of hops) and this was deducted from their point total.

3.2 Designing a Geospatial Guessing Game

A common feature of mapping systems such as Google Maps [6] is that they allow users to tag locations of interest (using pushpins in this example) and to provide some descriptive content relevant to the area. The *Gopher Guessing Game* was an early concept prototype that aimed to tag locations in the real world through gameplay. Development of this minigame within Gophers was inspired by the projects previously mentioned (The ESP game and Peekaboom). These pit players against each other in a game where they must agree on a descriptive word or salient areas for a particular picture. As an outcome, accurate labels and marked areas of interest for images are produced. The guessing game extended this idea to label physical locations.

The design of the Gopher Guessing Game aimed to address a number of issues: (i) to allow asynchronous matches (so players did not have to be connected at the same time), (ii) to discourage copying of content from peers, and (iii) to reward for the supply of semantically appropriate information.

The essential game design adhered to the following logic:

Players enter words to describe their current location and are rewarded for guessing the same word as other players.

Early game designs, with only the current cell being considered, resulted in low participation from users because matches were rarely achieved. Phenomena such as mast flipping [3] and the high density of mobile masts in urban environments [7] meant that two guesses made at the same location could be tagged to different cells. As a result, the initial simplistic design was revised to reduce the location specificity that was required, whilst still rewarding appropriate guessing. In the final version of the game, two further revisions were made. First, to encourage original guesses, points were awarded on a decreasing basis relating to the number of players who had already guessed the word at that location. A maximum of five players was set, at which point players would be asked to guess again. Second, to discourage players from 'pairing up' and intentionally entering the same words into the game, each time the same two players matched, the points awarded would diminish.

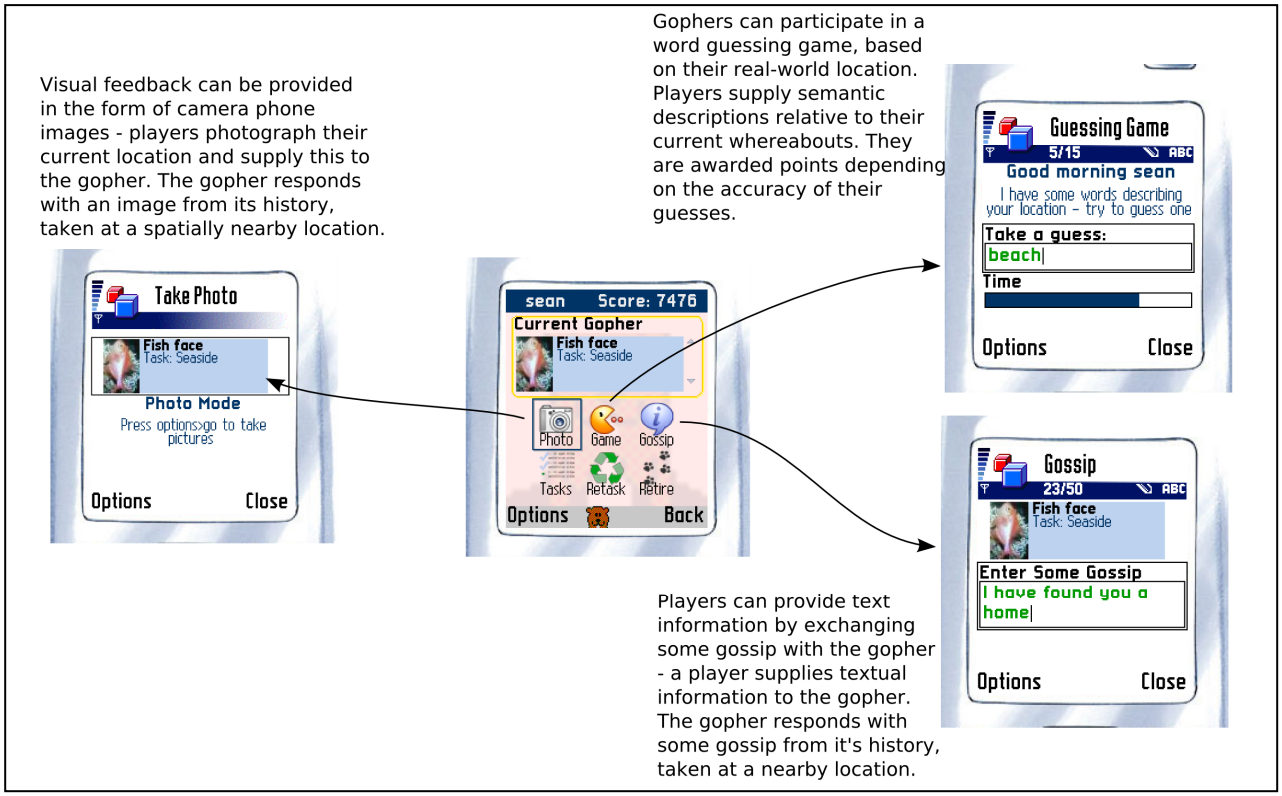


Figure 2. Real world experience, interacting with gophers

The final set of guessing game rules were as follows:

A player enters a word to describe their current location. If other players have previously entered the same word at this location, this scores a direct hit – and both players are rewarded with maximum points (reduced if the same players have matched before and depending on whether other players have already matched with the word at that location). If the word matches with a nearby location, then points are awarded decreasing with distance (up to a maximum of four hops). Otherwise, if no match occurs, then their current cell id is tagged with the new word in the node database, and points are awarded for any future hits.

These (overly complex) rules were not made explicit to the players; rather they were suggested through subtle messages when guesses were made.

3.3 Sharing Photo and Textual Content

Photographic content was supplied to the game via camera phones. Players took images relevant to the gopher's current task, and these were used as evidence in the trials. Photos were tagged with the user's current cell id and stored in an image database. These images remained associated with the current gopher and appeared in the gopher's blog.

To enhance the content sharing experience, and to offer a reward for player participation, when given a new photo a gopher would reply by returning a photograph of its own. This image was selected from the gopher's historical knowledge of photos that had been tagged at spatially nearby locations (and not already returned to the current player) - perhaps an image most likely to be of relevance to the player's immediate context.

Similarly, players could also supply 'gossip' information to a gopher. Gossip was a single line of text that is of relevance to the gopher's mission. Again, this was rewarded with a piece of gossip originally acquired by the gopher in a nearby cell location.

3.4 Peer Reviewed Content Assessment

After a player claimed that a gopher had completed its task, the content of its blog was considered to ensure the task had been properly completed. In addition, the task difficulty and the key participants who helped complete it also required consideration. Analysis of blog content is a subjective matter that clearly requires human input. To achieve this and also indirectly act as a quality control for content supplied to the game, a unique peer-judging system called 'Jury Service' was created.

On logging into the gophers website, the player was presented with a web interface. This was primarily used by players to view the blogs of gophers that they had interacted with. It allowed them to determine if a task was complete, or whether further action was required.

A gopher was submitted to jury service when a player specified 'task complete' from their mobile client. As soon as this was done, a new trial was initiated for that gopher and jurors emailed invitations to take part (in addition, players were notified via their phone when they next interacted with the game). The jury was made up of the 5% of players who stood on a trial panel least recently, or had never taken part. Although not strictly compulsory, participation in jury service was worthwhile, as jurors were rewarded points for their contribution.

Jury trials were held over 24 hour periods. During this time, jurors could independently login to the web hosted system and cast their votes. Presuming a sufficient number of jurors participated in the trial, it was closed after the 24 hours and the outcome calculated. Using mean responses from all the voters, three key decisions were made: (i) had the task been completed? (ii) how difficult was it? and (iii) which individuals helped the most? Points were then calculated based on these outcomes and distributed to all parties involved in the trial.

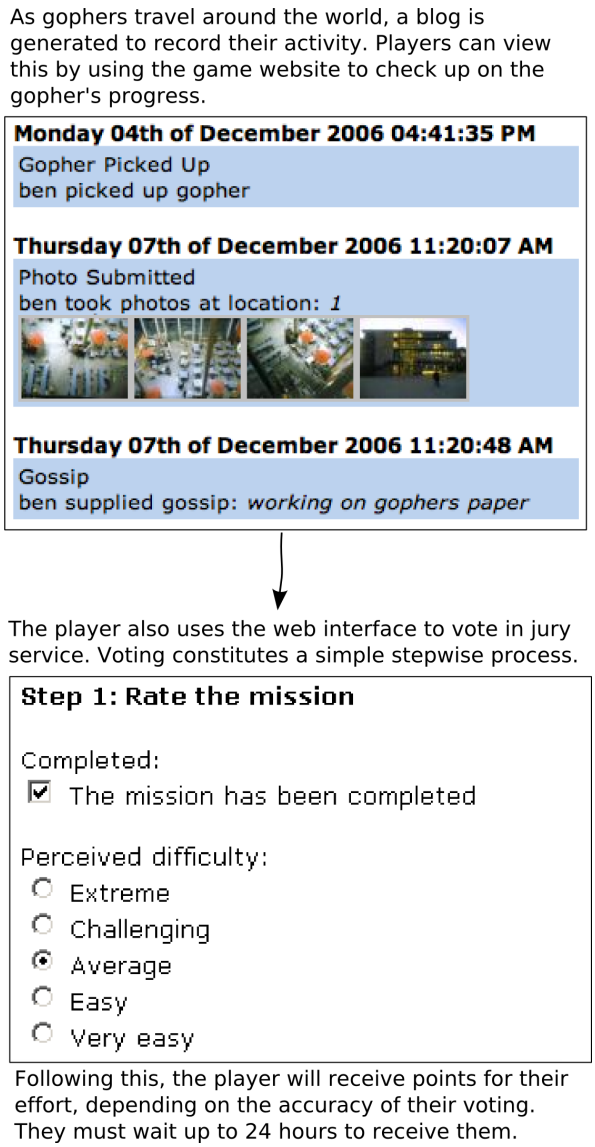


Figure 3. Web experience

If the mission was judged to be complete, the player who originally created the gopher was awarded points relative to the perceived task difficulty and each of the individuals who helped complete the task were awarded points depending on how much they were judged to have helped in the mission. Otherwise, the mission could be voted incomplete. In this case, the gopher was re-released and would return to its last known location where it would wait for a player to pick it up and help with its task.

Regardless of the outcome of jury service, jurors always received points for their efforts. The number of points awarded depended on how close their votes were to the median responses, thus rewarding honest voting.

On paper, this scoring system appears complex (perhaps overly so). This is due to the many different requirements incorporated into the in-game economy. Part of the challenge of developing the system was hiding this complexity from players, yet exposing enough to indicate which actions were rewarded and which were penalised. This was achieved by only releasing small snippets of information when it was relevant to players (via popup messages); when a player was invited to jury service for example, they were informed 'you will receive points for your effort'. An additional challenge in developing the system was fine tuning the number of points awarded for the various activities. This was an ongoing process that continued throughout the trials. Since the scoring system was part of the server-side back end, it could be modified without alterations to the mobile client executable.

4. TRIALS

Because of its dependence on user generated content, Gophers relied on a certain level of deployment for its operation. In order for the game to function, a 'critical mass' of participants was required. A sufficient number of dedicated players were needed to supply content in order for the game to become interesting. Once this point was reached, players were more likely to participate out of interest. Two options were considered for trialling the games:

4.1 Remote Distribution

The game was initially downloadable from the Gophers website, using a mobile OTA installer. In this first attempt, players used their own personal phone to run the game and the intention was to allow the trial to continue for as long as active players existed. It was envisaged that this method would have the advantage of achieving a sparse distribution of a large numbers of players. Additionally, through using their own phone, already a part of their daily lives, players would receive a more natural experience utilising technology with which they were already very familiar.

The game was advertised on relevant mailing lists, blogs and websites, but limited recruitment success was achieved. There are a number of factors that could have discouraged individuals from participating. Since the game was experimental, no guarantees could be given regarding the effects of running it. So, players may have been reluctant to play using their own phone since the cost of data transmission could not be assured and there was the possibility of the corruption of personal data, or even damage to their handset. The principle of informed consent required that players be aware of these potential issues before joining the study; a click-through disclaimer was used before the game could be downloaded. Additionally, players could have been discouraged by age restrictions. Because the game contained large portions of user generated content that was not moderated, players were restricted to being over 17 years old (and later over 15 with parental consent). A final cause for poor uptake was the very specific hardware requirements. The game utilised the PlaceLab toolkit for location data [7] and this was limited to running on a particular subset of Nokia Series 60 2nd Edition cell phones.

4.2 Organised Distribution

Due to the difficulties described above, the studies were conducted using organised trials. In these more controlled, small scale user trails, players were recruited to participate and supplied a phone with the software preinstalled. Their play activity was monitored through log data and with self-documented daily diaries. The trials acted in a more formal ethnographic style, where players could be more closely monitored in the field.

4.3 Full Trials

Two formal trials were organised in and around the City of Lincoln. The first was a preliminary trial and was used to assess the functionality of the original game concept. Players were introduced to the game during a university lecture. The trial involved six university students who played the game over a period of eight days. A post-trial interview was held and responses filmed. The second game trial involved 13 A-level students from a local VIth form. This trial ran over 18 days during the school Christmas holiday. In each case, players were supplied a Nokia 6680 phone with sufficient credit for the duration of the game and given a brief printed synopsis of the rules.

Players were asked to complete a 'game diary' over the first seven days of the trials, to monitor their play; a technique that achieved a good range of responses when assessing Feeding Yoshi [1]. In addition to the content supplied in the questionnaires, game interactions were logged on the game servers. Combining these data sources provided an accurate depiction of game activity. On the last day of the trial, a more general questionnaire was completed by the participants that was designed to investigate player opinion of the trial as a whole. Post trial, the groups were interviewed and debriefed.

The games were both primed with a number of sample gophers and players were given enough points to create two gophers each.

5. RESULTS AND ANALYSIS

The following is a discussion of trial results that reflect upon the key research themes identified in *Section 1*. Generally, the trials set out to answer a number of questions:

How effective was the game as a pervasive/social experience?

Was the in game content sufficient to support this?

What type of content was collected?

Were there any notable 'useful' patterns in this data?

Are games of this type feasible on mobile devices?

5.1 Gameplay Observations

There were a number of important findings to note after reviewing the questionnaire responses from the second subject group.

The group as a whole were already familiar with the capabilities of mobile technology as a social tool. Eight out of the ten respondents from the school trial group reported they used social networking sites and regularly played computer games. All of those that responded reported that they consider themselves good team players.

An interesting observation concerned the way that players acquired an understanding of a distributed game's rules. The rules were not known *ab initio*, and players were seldom co-located (where they could share their understandings). Each player therefore had to discover how to play the game for themselves. This could have actually encumbered competition, since to play most effectively players required a shared knowledge of rules and the play gestalts. This illustrated a problem for mobile and distributed games more generally.

Overall, player feedback showed that the game was interesting to play. All respondents bar one, reported to have enjoyed participating. However, initial responses indicated that a significant number of players (four) did not properly understand the game's mechanisms, which gave the impression that, although some aspects were successful (the guessing game and photo modes were amongst the favourite features), the game was too complex as a whole. As the trial continued, comprehension of the game increased; this highlighted a noticeably steep learning curve for new players.

Within the group of A-level students, the school became a focal location of the game. Players used breaks and other free periods during their timetable to interact with the game and discuss it with other players and spectators.

Although the game was pervasive, most people preferred to play at static locations: watching TV, in the school common room or on the computer. Players were less keen on interacting when walking about; possibly because the length of interaction time (delays due to HTTP communication speed over GSM were significant).

Willingness for players to supply user-generated content was paramount to the game's success. As discussed in section 4, it was vital that players provided sufficient quantities to maintain interesting and varied gameplay. Trial results have indicated that players were willing to supply this information for at least the length of the trials.

5.2 Guessing Game and Geospatial Tagging

The words supplied to the guessing game were geospatially connected to their associated locations. Words for a particular area could be graphically displayed using a visualisation tool (see Figure 4). This representation was designed to highlight spatial patterns in the data set and through doing so, allow the game's ability to collect worthwhile geospatial information to be assessed. The visualisation organised the nodes using a non-weighted spring algorithm. Active nodes, where interactions between player and gopher occurred were coloured red. Next to each, ranked lists of the five most popular tags for the cell were indicated. Without the geographical coordinates of the actual cell masts, there was insufficient data to connect these nodes to precise physical locations. The resultant graph simply showed a set of cell masts, organised in a fashion that balanced their interconnecting edges. Spatial relationships between these graphs and the physical world were clear when compared to a cartographic map of the area. For example, when the graph in Figure 4 is compared with the geographical area, a number of similarities could be identified. Ids 1, 13 and 3, at the bottom left of the graph were associated with the university campus; words such as *campus*, *university* and *Brayford* were listed; these corresponded to the Brayford Pool university campus, in the southwest of the city. Id 10 contained the descriptors *big* and *cathedral*, mapping to the

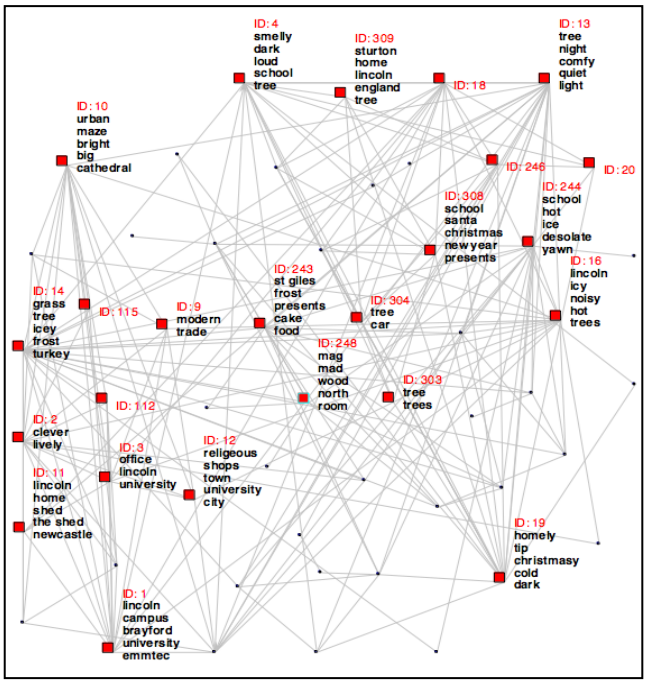


Figure 4. Spatial representation of guessed words

cathedral quarter and ids 308/244 both contained *school* tags, connected with the secondary school in the northeast of the city.

It was only possible to see any relationship between visualised graphs and physical topology in the heavily played urban areas, such as central Lincoln. This was due to the more established links between nodes in these areas. Similar comparisons in less well travelled areas produced few relationships between node layout and spatiality, as the graph had insufficient information to converge in an organised fashion. Despite this, there were always strong semantic links between content and the cell mast to which it was tagged.

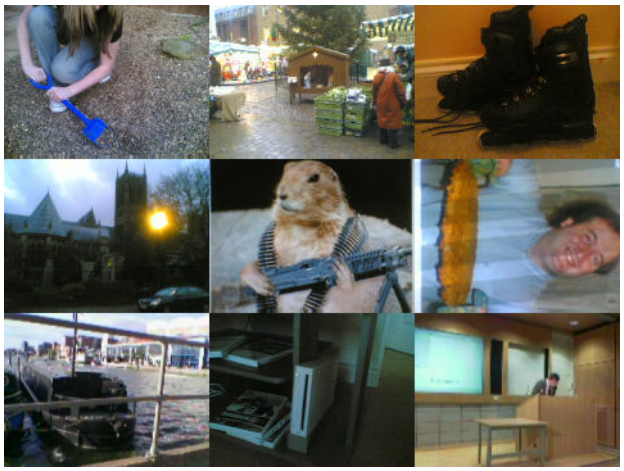
The design of the guessing game did not attempt to impose a naming ontology [7] on players. As a result, descriptive location tags were not the only words supplied. It was common for players to supply 'feelings' or emotional words to describe an area. In the vicinity of the school, for example, words like *ice*, *desolate* and *yawn* were included. This was interesting, as it could indicate a 'social vibe' for a particular area. In the right context, emotive descriptions like this could be as informative as place names. Also common were descriptions with personal, but little group meaning (such as *home*), fun and seasonal words with little spatial relevance (*jelly*/*christmasy*) and the inevitable juvenile humour (*gay*). This provided an interesting insight into the naming conventions that people intrinsically associated with their everyday location and context.

5.3 Text and Photo Gossip

Text and photos supplied to the game were manually reviewed by sight. A randomly selected set of gossip and photo entries has been produced to demonstrate a sample of this content (Figure 5). Most of the supplied photos were connected with the gopher's task (two thirds of users claimed to try and supply task relevant content),

suggesting that the presence of jury service was successful in promoting good content. However, it was also noticed that a large portion bore no relevance. This was supported by player comments, who reported to enjoy "taking photos of random rubbish".

Because the content was not moderated and could be communicated to other players, there were obvious ethical considerations to be addressed. One player reported this in a questionnaire "*Tasks involving the photographing of a third party…are causes for concern*". Another showed concerns about an investigative task that required players to find and photograph a certain member of staff's office, reporting in a piece of gossip "*but is this ethical?!*" These are certainly concerns that are warranted and would need to be safeguarded against if the game achieved wider distribution.



"skegness is an hour away by bus"

"the football pitch is next to the sports centre"

"there are some good takaways on the high street."

"ive found santa hes down town"

"beer is good :-)"

Figure 5. Selection of user supplied photos and gossip

Another unforeseen feature of the photos was that the content did not necessarily reflect the location in which they were taken. Some of the more unusual images supplied to the game (e.g. man with giant cookie) were taken from the Internet, television or printed images. These images tended to be linked to the 'armchair' players discussed in Section 5.1, who preferred playing the game at a static indoor location.

Overall, the responses received gave the impression that players enjoyed being exposed to new locative photo and gossip content by the gophers. Unfortunately, reduced gopher sharing in the second trial, due to the hoarding of gophers, limited the amounts of content players were exposed to (a gopher only replied to a player with content that the player had not themselves supplied).

5.4 Playing Cost

Cost of play is an important factor for users of connected mobile games. Querying location via cell id is cost free, so the only cost involved in Gophers was data transfer. These transfers were logged, allowing for easy analysis of the play cost. During the school trial 5,632 server requests of varying length were made from the 13 client devices. The mean cost of a single transaction was calculated to be £0.029GBP.

5.5 Future Design Improvements

There are a number of suggestions to improve the game design of Gophers:

Further use for user generated content: Gopher type agents could be assigned specific context dependent data collection tasks in monitoring applications. For example, information collected regarding player context could eventually be used to allow gophers (or other pervasive systems) to act in a more intelligent, situation-aware manner.

Simplification of features for less experienced players: Player feedback indicated that the learning curve was too steep for a casual mobile game and the length of typical interactions too long. An improved approach would be to incrementally 'unlock' new features as play commenced, preventing the novice player being swamped by the initial feature set. In addition, this improvement may additionally reduce overall interaction times and hence assist with mobile participation.

Gopher movement: The boredom threshold (where a gopher would leave the phone after a specified period of inactivity) was originally an attempt to reduce 'hoarding' of gophers on a player's phone. This did not take into account that the phone could be turned off, effectively 'trapping' the gophers. Analysis of server logs showed that many of the gophers who did not complete their tasks had been trapped on the phones of inactive players. As an improvement, the server could be made to release the gophers a player was holding after detecting a disconnection.

Reward mechanisms: Currently, players are rewarded with points for good performance and indirectly, the ability to create new gophers. An alternative might be to reward players with access to new game features (effectively acting as a level system) or allowing them to increase the spatial 'scope' of gophers (i.e. better players could be given the ability to create gophers that could travel further). This could be a vital mechanism for controlling agent populations in a larger scale game.

5.6 Future Work

The guessing game collected responses that acted as a powerful descriptive connection to real-world locations. Future applications could interpret this data in order to create more context sensitive aspects of gameplay. Through further analysis of locative content, it may also be possible to categorise spatial areas (for example, if numerous players are guessing the same words in one particular area). Similarly, it may be possible to identify areas depending on player type (players who share a particular interest may label areas in a certain way). This could provide enhancements to social aspects of the gameplay.

It would be more difficult to include photographic and descriptive content in such analysis. One method of mitigating this problem could be to present the content to a second player who would examine the information and provide a response. The meta-responses, rather than the source content, could then be used in the analysis.

6. CONCLUSIONS

Overall, the trial has shown mixed success. It has presented the small-scale orchestration of a mobile social game that incorporated spatialised user generated content. Furthermore, it has demonstrated that gameplay based around pervasive real-world tasks can create an engaging and fun experience over a sustained amount of time (18 days). Through visualisation of this content, we have suggested methods by which this could be exploited for future uses, beyond the field of entertainment.

Additional applications that Gophers type technology could aid with have been considered. Firstly, multiplayer games as a whole provide a rich environment in which to study the social networks that build up through normal play. Gophers and pervasive games demonstrate a more ecologically valid platform for this.

Further uses may be found in ubiquitous computing scenarios where content is disseminated into the environment and presented to users at the appropriate times. For example, an application where a number of gophers could be personalised for different tours [11] and 'trained' with content for each. A user could pick up the appropriate gopher at the start of the tour that would then stay with the user, allowing them to roam freely along their chosen route and offer up information when at the appropriate location or context. This method of delivering the tour narrative via an agent is a much more natural approach than the rigid presentation experienced by an audio guide, for example.

Finally, the study allowed us to test a number of new game concepts that individually showed promising results. The amount of time players participated in the guessing game was particularly encouraging. As a whole the game was undoubtedly too complex for beginner players. It has demonstrated some of the pitfalls of mobile games development, particularly concerning the shared comprehension of a set of rules between isolated players. The results have motivated the further development of the guessing game concept into a more mature, stand-alone format.

7. ACKNOWLEDGMENTS

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