

MobiLenin – Combining A Multi-Track Music Video, Personal Mobile Phones and A Public Display into Multi-User Interactive Entertainment

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ABSTRACT

This paper introduces a novel and creative approach for coupling multimedia art with a non-conventional distributed human-computer interface for multi-user interactive entertainment. The proposed MobiLenin system allows a group of people to interact simultaneously with a multi-track music video shown on a large public display using their personal mobile phones, effectively empowering the group with the joint authorship of the video. The system is realized with a client-server architecture which includes server-driven real-time control of the client UI to guarantee ease of use and a lottery mechanism as an incentive for interaction. Our analysis of the findings of an empirical user evaluation conducted in a true environment of use shows that the MobiLenin system is successful, addressing many of the challenges identified in the literature. The proposed system offers a new form of interactive entertainment for pubs and other public places, and the underlying architecture provides a framework for realizing similar installations with different types of multimedia content.

Categories and Subject Descriptors

H.5.1 [Information Interfaces and Presentation]: Multimedia Information Systems – *evaluation and methodology, video*. H.5.2 [Information Interfaces and Presentation]: User Interfaces – *evaluation and methodology, input devices and strategies, interaction styles*. H.5.3 [Information Interfaces and Presentation]: Group and Organization Interfaces - *collaborative computing, computer-supported cooperative work, evaluation and methodology*.

General Terms

Design, Experimentation, Human Factors.

Keywords

Multimedia art, hybrid interfaces, experimental evaluation.

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1. INTRODUCTION

This work introduces the MobiLenin system which combines a multi-track music video with personal mobile phones and a public display into interactive art for the purpose of enticing social interaction between people.

According to Tosa [22], interactive art can be thought of as an emotion and sympathy interface, and interactive art is a component that provides sympathy with communications. Adams and Moussouri [1] define the interactive experience as something that can actively involve the visitor physically, intellectually, emotionally, and/or socially. Ryan [20] claims that an interactive medium opens its world after the user has made a significant intellectual and emotional investment. According to Maynes-Aminzade *et al.* [12], the greatest challenge does not lie in developing the technology for audience interaction, but in designing engaging activities.

In previous related works people have been able to control onscreen activity by leaning left and right in their seats to steer a race car or move a paddle in the video game Pong, or by batting a beach ball while its shadow is used as a pointing device, or by pointing laser pointers at the screen [12]. In the Cinematrix Interactive Entertainment System [9] the audience members can participate interactively in activities such as maze navigation and opinion polling by displaying the red or the green side of a paddle. Since then relatively little progress has been made in the study of audience interaction [12].

Churchill *et al.* [6] argue that there are significant opportunities around the corner for distribution of interactive multimedia digital content designed for social networking and entertainment. Rogers and Lindley [18] state that there has been little research on how deploying public displays in different places invites certain kinds of social interactions. Instilling a sense of community is one motivation in situating large interactive displays in a variety of work and public places [18][7]. According to Paek *et al.* [14], interactive shared displays are most suited for certain types of applications, including “collaborative tools allowing multiple people to contribute to a single goal”, and “arena applications involving competitive interaction”. The MobiLenin system incorporates both of them to instill a sense of community and to entice social interaction among the users.

Vogel *et al.* [23] present the questions what kind of input and interface technologies do we need to develop to allow for

effective interaction with large public displays? Many large display systems are currently single-user based and require users to take turns when interacting with them. However, there is a growing body of work investigating the use of multi-user interactive displays [4]. Maynes-Aminzade *et al.* [12] state that systems enabling large audiences to interact offer numerous possibilities for entertainment, but most research on interaction techniques focuses on single users or on small groups.

Magerkurth *et al.* [10] propose to augment traditional entertainment technology with social and physical elements to form e.g. a new class of hybrid gaming applications. This leads to a thought that mobile devices could be employed for this purpose. Reid *et al.* [16] report *Schminky*, a musical game where a PDA is used to interact with other players over a WLAN (Wireless Local Area Network) in a café.

The MobiLenin system offers a solution for realizing multi-user interaction with a public display using personal mobile phones. Public displays and personal mobile phones make an interesting couple in terms of strengths and weaknesses. While shared displays typically offer greater conceptual power and larger presentation space, they often limit interaction to one user at a time. Personal mobile phones, on the other hand, disperse control and access to participating users, though limited conceptual power and smaller screen sizes often hinder dynamic interaction. Thus, connecting shared displays to personal mobile phones is an obvious way to leverage the best of both worlds [15].

One of the main challenges associated with interactive public displays is how to entice people to interact with them [3]? Agamanolis [2] concluded that half the battle in designing an interactive situated or public display is designing how the display will invite that interaction. Churchill *et al.* [6] found that users needed constant encouragement and demonstration to interact with the interactive public display. The MobiLenin system employs a lottery mechanism as an incentive for interaction.

We see that there is a need for designing engaging activities which make the users feel invited, interested and encouraged to interact. At the same time they have to have a reason to focus on what is shown on the public display. To rise to the challenge, we present the MobiLenin system, which builds on the combination of multimedia art, a public display, personal mobile phones and a client-server architecture. The principal idea of the MobiLenin system is that each user can with his/her personal mobile phone interact with an interactive multi-track music video shown on a public display. Each user can individually vote for one of the tracks by selecting the corresponding choice from the menu in the mobile phone application, and the track receiving most votes is shown. Thus, the MobiLenin system empowers the users with a joint authorship of the interactive art piece. As an incentive for interaction, the system contains a lottery mechanism which under adjustable circumstances chooses a winner among the users having voted in a given voting interval.

This paper is organized as follows. Section 2 describes the MobiLenin system. Section 3 presents the experimental user evaluation of the system in a true environment of use. Section 4 provides an in-depth analysis in regard to design issues, social experience and collaborative aspects. Section 5 summarizes our major findings for future work, and explains how the MobiLenin architecture could be used for developing other artistic concepts.

2. THE MOBILENIN SYSTEM

2.1 Artistic motivation

My (the lead author's) motivation as a music, new media artist and engineer was to create an interactive technology system that gives the audience the possibility to engage in a new way in my live show - simply by interacting with the music and video on a large screen. The idea is to enhance people's concert experience by allowing them to interact with the artist in the virtual domain (display). Through the virtual domain people can interact with attributes and scenarios (e.g. turn the artist into a skeleton) which can never be offered in the physical domain on stage - simply due to the physical limitations.

The MobiLenin system has its roots in two previous interactive art pieces, which I have created and performed on stage. In the first installation shouting and clapping of a crowd of people was used to change the tracks of a multi-track music video shown on a public display. This was done via measuring the sound input level (volume): the louder the shouting and clapping got, the wilder the performance of the music artist in the video. Field tests showed that the system generated strong group participation and dynamic group behaviour. In the second installation a large green coloured ball filled with air was thrown into the crowd of people. The position of the ball was estimated with a camera based tracking system and mapped to a certain interaction event that resulted in changes in the content of the public display. The MobiLenin system is the third iteration, providing a much richer set of features including empowering a group of users with the joint authorship of the art piece.

The system should be able to absorb the energy and atmospheric state of the audience through their interaction, so that a feedback loop occurs. The design of the system should be such that it can be used for large audiences but also in pubs for small groups and co-located group action in public events. On one hand the interaction affordance should offer elements of collaboration for large but also small crowds. At the same time there should be an individual backchannel to people to reward them for their participation in the interaction (e.g. lottery - winning a CD). The interaction should trigger social engagement with other people and be fun and easy to use.

The system should generate its own unique artistic expression which feeds to people's emotion and sympathy. It should also give them a fresh and positive experience that fits to the brand of the music and appearance of the artist.

By providing my own music and producing the music video (interactive art) as well as doing the system design, the interaction design as well as the coding of the client server system and the mobile application for the MobiLenin system, I tried to use my artistic approaches to create a unique but in itself coherent interactive system. Through this system the nature and expression of my art should reach people's emotions and mind.

By using my engineering skills in combination with my skills for producing multimedia content and writing original songs - namely composing music, writing lyrics, producing music and doing live performance as well as video production - I try to jump to new levels of developing novel interactive systems and interactive art pieces that inspires people to carry them to new heights of interactive experiences. The MobiLenin system is one of the first outcomes of this motivation.

The artistic aspects of this interactive art work are reflected in its appearance, the production process and the experience design. On one hand in the performance style and the aesthetics of appearance of me as the music artist in the video – namely through acting that allows people to naturally connect with me when interacting with me on the public display (non real). On the other hand in the music composition that I created to stimulate people’s mood and to entertain them. Also, the variety of experimental video techniques used to produce the video as well as putting together the various bits and pieces into a unique, in itself coherent interactive system, is parts of the artistic expression.

2.2 System architecture

The MobiLenin system is realized with a client-server architecture which comprises of three components: a Symbian client application running on a mobile phone, a server running on a PC, and a large public display showing the music video.

There are several reasons why the personal mobile phone is a suitable user device for our purpose. First, they are ubiquitous, as practically everyone has one. Second, they allow anonymous, wireless and mobile participation in a joint social public group interaction. Third, the mobile phone provides a reliable return channel for delivering confidential user specific information back to the user, such as the winning coupon of a lottery.

The client is implemented in Python following the Nokia Series 60 UI conventions. Each client is connected to the server via HTTP over a GPRS (General Packet Radio Service) data connection, which is supported practically by all available phones. We are not using Bluetooth connectivity, for then the server (master) would be able to connect to at most seven clients (slaves) simultaneously. Further, Bluetooth would restrict participation to users within a limited spatial range of about 10 meter radius from the service point, while the current implementation allows participation from far away, for example throughout the whole arena of a big concert. The client on each phone has a unique ID by which the server can identify them, controlling the state (UI) of each client in real-time via HTTP.

The server is implemented in Macromedia Director using scripting language Lingo [24]. The scripts take care of functions such as driving the state diagram, counting votes, lottery mechanism, initiating the delivery of winning notifications, and controlling the QuickTime player with its multi-track video. The scripts also handle all graphic elements on the public display as well as the sound output. An additional external server component consisting of simple PHP scripts is placed in the internet, acting as a mediator between the public mobile data network and the PC running the server application. The communication between the two is done via HTTP. The external component also hosts the pictures of the lottery coupons to be fetched by the mobile devices upon initiation by the server.

The large public display serves as the main user interface for the user’s interaction. In addition to showing the music video, it indicates the start and end of a voting interval, the voting results, and notifies the audience of somebody winning in the lottery.

Figure 1 shows the state diagram of the system. When the voting interval starts, it is indicated in the client via a Series 60 popup note (Figure 2(a)) and shown on the public display (“Vote now!”). The server opens the voting menu in each client, so that a vote is

cast by selecting one of the given menu choices (Figure 2(b)). If a vote is cast, it is acknowledged by the client (Figure 2(c)) and sent to the server. If the user wins in the lottery, a winning coupon is pushed to the client by the server and presented to the user (Figure 2(d)).

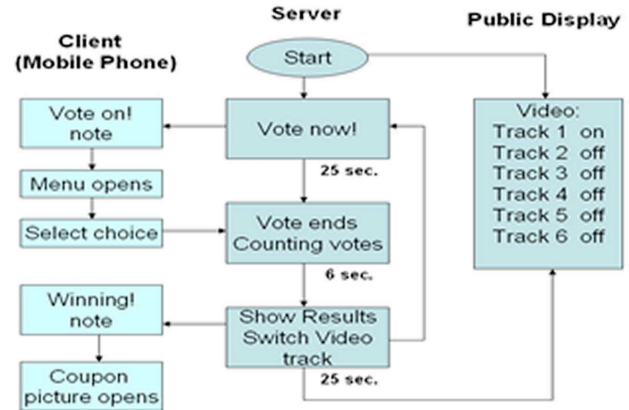


Figure 1. State diagram of the MobiLenin system.

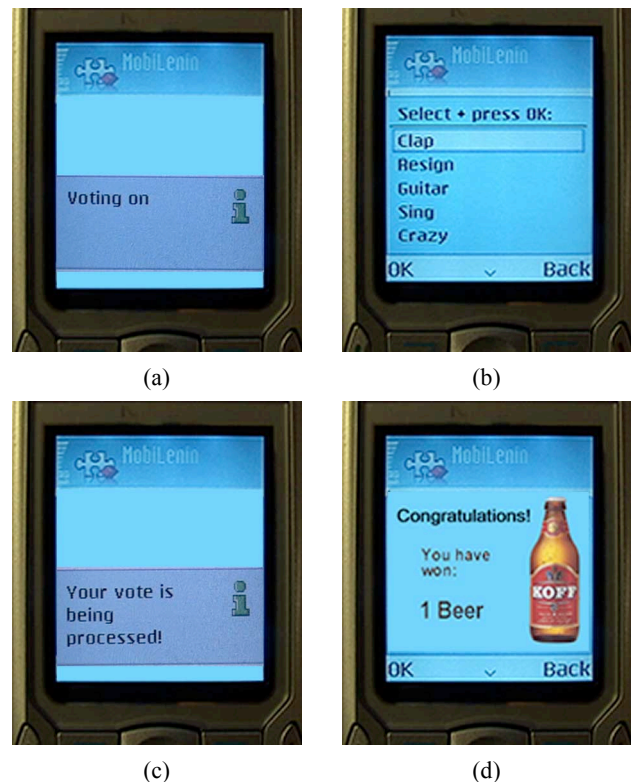


Figure 2. Screenshots of the client’s UI: (a) the voting interval has started; (b) casting a vote; (c) the vote is acknowledged; (d) a coupon has been received upon winning in the lottery.

After the 25 second voting interval is over, the server switches off the voting menu in the client, and “Voting ends! Counting votes!”

text is displayed both on client and the public display. The server counts the votes and after six seconds the result of the vote is displayed on the large display in form of six graphic bars, one for each voting option. The length of each bar corresponds to the proportion of votes each option received (Figure 3). The display of the result lasts 25 seconds and then a new voting interval starts.

The six different options in the voting menu correspond to the six tracks in the multi-track music video. Only one track is visible at a given time, determined by the collective vote of the previous voting interval so that the track receiving most votes is shown. The change of the video track results in a non-linear perception of the video on the public display.

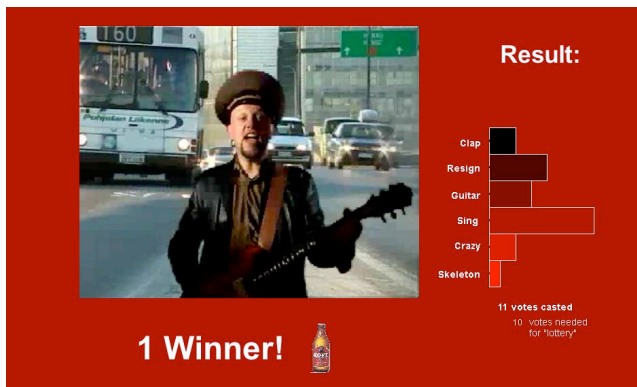


Figure 3. A screenshot of the public display.

2.3 Multi-track music video

The main character in the music video is the lead author's artist alter-ego known as "Lenin's Godson", which explains where the name MobiLenin comes from: Mobile and Lenin. The "Gogogo" song used in the music video is extracted from the artist's published albums, where it is available in three different versions of equal length: 1. a full version with guitar sound and singing; 2. a reduced version with guitar sound, but no singing; 3. a slim version with no guitar sound and no singing.

The music video employed in the MobiLenin system comprises of six tracks which are of precisely equal length and they are played in parallel and in sync, whereas only one track is visible at the time. The performance on the foreground is different in each track, whereas the background stays always the same. The six tracks are:

- clap*: he claps hands to the rhythm of the music (no voice, only slim music version with no guitar sound and no singing);
- resign*: (no voice, just gestures, still slim music version with no guitar sound and no singing);
- guitar*: he plays guitar (still no voice, reduced music version with guitar sound, but no singing);
- sing*: he sings and plays guitar (now also the voice is on: full music version with guitar sound and singing);
- crazy*: 'violent' performance (voice and full music version are on);
- skeleton*: he turns into a skeleton (still playing guitar and singing with full music version on).

The foreground video for the six tracks was shot in a studio against a blue screen. Each of the five performing styles of the artist was separately filmed with the full length of the song, leading to the five foreground videos. The footage for the sixth track - the skeleton - was produced via a stop motion animation using a plastic toy skeleton as the model in front of the blue screen.

In order to portrait a strong presence of the performing artist in the video, it was shot from the front using one fixed camera position. The artist was filmed from knee to top so that he was placed in the middle of the frame. This single position of the artist served as the reference position point in the frame, for the purpose of producing a coherent outcome in all of the six video tracks. In each track the artist needed to appear in the same spot, the same size and occupy the same space in the frame, otherwise the change of the track in the final multi-track video would appear unnatural to the viewer.

The footage for the background video was shot on a busy street in the middle of heavy traffic, and edited into exactly the same length as the song. As the next step each of the six foreground videos was overlaid over the same background video using the bluescreening technique. This guarantees linearity of the background, i.e. keeping the background stable and coherent despite the foreground (performance style of the artist) being changed at any point of the music video during the interaction.

The multi-track video was generated with the QuickTime player, into which the six video tracks and the three music tracks were imported as parallel tracks. A single QuickTime file was produced where all video and music tracks are in sync, each corresponding to a single layer (parallel QuickTime track). Each track can be enabled or disabled in real-time via a scripting language such as Lingo in the Macromedia Director used in the MobiLenin server.

3. EXPERIMENTAL USER EVALUATION

The MobiLenin system was tested in a real world setting in a local restaurant. As illustrated in Figure 4, the public display was situated 4-8 meters from the users. Each user was given a Series 60 phone containing the client application, and shown how to start the client. Then the interactive music video was started and people could cast their votes in each voting interval.

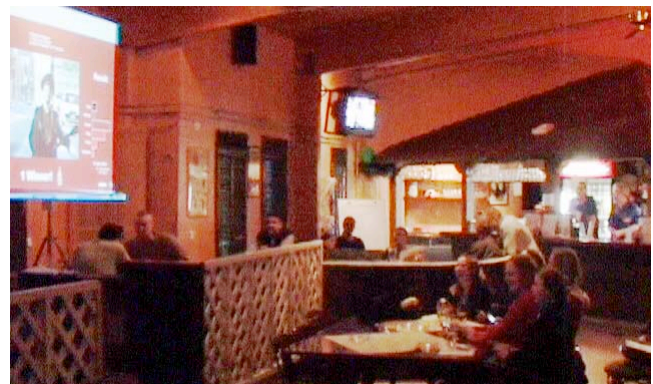


Figure 4. User evaluation in a real world setting on-going.

Research data was collected with various methods. Qualitative data reflecting the user experience was collected with a questionnaire, which each test user filled in after the experiment. The questionnaire contained 21 statements on which the users were asked to answer on a 5-point scale 1 (disagree completely) – 5 (agree completely), and 13 open-ended questions. Five individual users and a group of four users were also video interviewed after the experiment.

Observation was carried out during the experiment with three video cameras so that one fixed camera shot a panorama of the whole experiment, another fixed camera recorded the public display and a mobile camera shot close-up footage of users. A digital camera was also employed for taking still photos. Test users were informed about the observation before the experiment.

Quantitative data was collected by logging in the server, for the purpose on computing statistics such as individual votes, vote counts and outcome, as well as lottery results.

14 test users (eight males and six females) participated in the experiment, and for the most part they were recruited on the spot. The age distribution was 3 of 18-24, 8 of age 25-34, and 3 of age 35+. Each willing test user was served a drink of his/her choice before the start of the experiment, and another optional drink was served upon returning the questionnaire.

The lottery mechanism was adjusted so that at least 9 votes needed to be cast in a given interval for the lottery to take place. If so then with a 50% probability a winner was selected among the users having voted in this interval. If a winner was selected, the prize was either a beer or a pizza with 50/50 chance. Test users were informed about the lottery mechanism before the experiment.

All 14 users used the system at the same time in a single session, during which the music video looped three times for a total duration of 11 minutes and 45 seconds. 13 voting intervals took place, with an average of 11 users casting their votes in each interval. The lottery system identified seven winners, of which two were awarded a pizza and five a beer.

A very clear general observation was that people enjoyed using the MobiLenin system. This was expressed by laughing, happy faces, good mood, and rowdy celebrations upon winning in the lottery. This shows that our system succeeded in designing an engaging activity by making users feel encouraged and invited to interact with a large display, which was identified as a major challenge in the literature review.

4. ANALYSIS OF FINDINGS

In the following we discuss various aspects of the MobiLenin system and the experimental evaluation, relating our findings with the relevant literature. For brevity we adopt the following notation: “Statement” (X/Y) means that X users agreed (answering either 4 or 5 on the 5-point scale) with “Statement” and Y users disagreed (answering either 1 or 2) with the statement in their questionnaire. *Test user’s comments are printed in italic.*

4.1 Social setting

Past research on audience participatory systems shows that the physical and social setting is essential to interactive systems such as the MobiLenin system. According to Churchill *et al.* [6], the

social setting drives the extent to which the technology is perceived as functional or playful or both.

Brignull *et al.* [4] used a large interactive situated display to provide a public interactive surface for the cooperative sharing and exchange of media in their Dynamo project. The users reported that the display promoted a social atmosphere and generated opportunities for people to engage with others that they would not normally talk to. Similar findings have been made also by others, as well [3][13].

Observations by Churchill *et al.* [6] of their Plasma Poster revealed that the physical and social setting has a strong effect on how and when people “interface” or interact with content. They maintain that the entire social and physical setting is the interface to the consumption of the content, not just the interface-as-display.

Maynes-Aminzade *et al.* [12] have conducted over 30 tests with 150 to 600 participants in each, which demonstrated that social involvement is more important than technological involvement. According to their findings, audiences become very emotionally involved in polls and trivia, particularly when the topic of the poll is a highly contested issue, or when several audience members believe they know the correct answer to a trivia question.

The participants’ comments in the video interviews after the experiment indicate that the interaction experience with the MobiLenin system was perceived as a highly social and exciting experiment: *“It was pretty social actually, more social than I was expecting.”*; *“I felt being part of the group, enjoyed the social side of the event.”*; *“The most interesting thing for me to be here was to be a group, it was a social thing.”*; *“There was time to make jokes in between, this was social happening.”*; *“The experiment was exciting, it was thrilling, I liked it.”* This shows that the MobiLenin system as an interactive entertainment generates a strong social setting and succeeds in designing engaging activities which has been identified as a major challenge in the literature.

In the following we discuss the potential factors contributing to the successful creation of the social setting.

Co-location. Magerkurth *et al.* [10] state that many forms of entertainment (e.g., sports and board games) heavily rely on human factors in creating a joyful interaction experience. Looking at computer games, they maintain that in terms of social richness today’s co-located computer gaming is far behind other popular game types such as board games. The difference is attributed to board gaming sessions creating a much stronger social situation than a computer game session. They propose augmenting traditional entertainment technology with social and physical elements to form a new class of hybrid gaming applications. These hybrid applications should integrate the social dynamics of co-located groups with computer games via interfaces that do not distract from the group situation.

MobiLenin stimulates inter-personal social interaction in co-located groups in front of the public display, and the system supports the social dynamics of the groups with its easy to use interface. The system allows multiple users to cast individually anonymous votes for a common goal, which contributes towards a strong social experience as a group. Participants’ responses after the experiment underlined the social interaction of the co-located

groups: "I felt I was part of the group."; "When you are in here you feel the size of the group, then it is quite nice to see what is coming on the screen."; "The most interesting thing for me to be here was to be a group, it was a social thing also that the whole group was not too big."; "It made me feel belonging to the group"; "The experience was nice, group fun." "This interaction experience would have been better if I would have been alone to interact with the display" (0/12).

Face-to-face contact. Magerkurth *et al.* [10] point out that face-to-face group settings with natural means of interaction between players inevitably create social situations. The richness of human-to-human interaction involving eye contact, mimics, and gestures is far from being captured in the purely virtual game play of computer games. Direct face-to-face interaction should be enabled and new interfaces between the players and the virtual domain must be introduced. These new interfaces are to ensure both the group situation to remain socially adequate and the transition from and to the virtual domain to be performed effectively [10]. The mobile phone used in the MobiLenin as the interface to the virtual domain (public display) appears to be a suitable user device for such purpose, as it allows direct face-to-face interaction with other players during the joint social public group interaction.

Awareness of what others in the co-located group do. Rogers and Lindley [18] state that the selection of appropriate interactional resources is what enables group members to keep aware of what each other is doing, enabling them to be tuned into the various needs of collaborative working. Further, for collaboration to be generally considered successful, each member must maintain awareness of what the others are doing. This underpins what our participants experienced: "With a small group you feel you can really have feeling of voting. Otherwise it's like tv-chat and that's not so cool."; "If it is e.g. like a TV channel and the audience is too big, then it goes like these TV chats and it is not a big deal at all what is the result, but when you are in here you feel the size of the group, then it is quite nice to see what is coming on the screen".

We observed that people were sitting in small groups of 2-3 people, discussing among each other on what was shown on the display and making jokes about it. This shows that our system provides the means for people to be aware of what others are doing within the interaction experience.

Private and public GUIs to foster social dynamics. O'Hara *et al.* [14] tell that large displays in public spaces afford different forms of engagement with content. Magerkurth *et al.* [10] go further by stating that both private and public GUIs should be available to foster social dynamics. In order to create private, shared, and public information in the social domain, it is essential to provide additional private interfaces to the virtual domain. MobiLenin provides both public and private GUIs. The display serves as the public GUI for sharing public information. The personal mobile phones serve as the generic private input and output device for entering private commands (votes) and receiving private information (winning coupons).

The participants' feedback speaks in favour of combining a public display and personal mobile phones for interaction: "Being in front of screen, having mobile phone in hand to interact with screen works and is the best way for this sort of interaction. It is easy because people are used to phone."; "This system has huge potential in very many ways, e.g. use the same kind of idea in

many different situations to have the chance to do the interaction with screen and mobile."

Spectator view. Reeves *et al.* [17] have explored how crafting interaction for public settings is affected by spectators. Churchill *et al.* [6] report that during the evaluation of their Plasma Poster in a community setting spectators watched people reading and interacting with content. Video recording of our experiment shows that the role of a spectator was a part of the social setting. People from all over the restaurant gathered close by the public display, watching the music video and the participants of the experiment, and contributing to the social atmosphere by laughing and shouting. The spectator view was also present among the participants, as demonstrated by the following comments: "It is fun if you see how people are reacting or when they are voting - it is something in common."; "It was fun to see the interaction of the people."; "It was fun to watch who wins."

Drop in drop out. MobiLenin allows people to join the interaction at any time, as well as refraining from it. This gives users the flexibility to follow their own agenda and moves. In their Schminck application Reid *et al.* [16] used PDA's for gaming in a café. As one important finding they report that the PDA allowed players to sit wherever they like, without invading the space of non-players, which made its impact on non-players less intrusive. Despite reservations about the intrusion of technology in public spaces, people value optional, spontaneous mechanisms to play co-located games. Their experience leads us to believe that such games should be designed so that they can be interleaved with other activities like drinking, eating, chatting, and phone calls. Dropping in and dropping out according to one's own agenda certainly is helpful in these situations.

4.2 Empowering a group of users with the joint authorship of the multimedia content

According to Manninen [11], the non-linearity in games can provide some degree of authorship to the player, and thus enrich the interaction. The question is to what extent this is valid for video. The MobiLenin system empowers a group of users with the joint authorship of the art piece. Allowing people to make changes in real-time to the music video and to direct its outcome on the large display by majority voting seemed to entice them to interact, both with the public display and with each other.

People seemed to like to be empowered with the authorship. This came across by the creative and imaginative answers by the participants when they were asked if they would like to change something else in the video with the mobile phone, and if so, what would it be? Among the answers was: "More instruments"; "Maybe clothes, dancing etc. to develop the character"; "More complex tasks"; "Constructing gradually an avatar with community would be nice"; "Different sort of music after a while. Other music instruments than guitar, maybe?"; "Music, clothes, the acting, background and more choices in voting menu"; "Maybe different kinds of music"; "I would have changed the setting, scene behind".

However, when asked how they felt about having the possibility to influence the video in real time by their mobile phone, the participants had mixed feelings. While some users liked the mobile authorship: "Fascinating, I could think the possibilities are endless on this field of mobile interaction. I will be looking

forward to more interaction like this.”; “The idea has a lot of potential.”; “It was nice.”, some users tentatively refrained from it: “It’s nice, but in the video the content is more interesting. For me choosing things is not self value.”; “Fun, on the other hand it could be annoying, frustrating, if the result is wrong in my opinion.”

Still, being empowered to make own selections about the visual appearance and the sound to affect the art piece motivated users: *“When just music was going on without singing - that was also one which really made a difference and I really felt it and noticed it.”; “It is content and real clear visual differences and lots of choices, that is like what is nice for me.”; “It was good to notice that the vote really made a difference”. Similar answers were given to the question “What was it that you enjoyed most?”: “To make man singing, content matters.”; “Social experience and Mr Lenin singing or going crazy!”; “The video was fun.”; “The music was good.” Answers to the question “What kept your interest up to continue to vote?” also support empowering the user with the authorship: “Different possibilities, so content”; “To see different actions in action.”; “Guessing what’s next.”; “To see if I would guess the outcome.”; “If there would have been more choices, or for example some other mime too.”*

We can conclude that empowering the user with certain authorship to affect the outcome can create new types of interactive experiences for people.

When the users were asked with what type of content they would like to interact, we got a variety of answers: *“Connected with interests of people e.g. different music styles, pop, rock etc. so people could find and see what bunch of people you have there, who likes what.”; “Avatar, lot of different properties to construct the avatar, would be interesting to see if a group could construct it, so to change features to other parts of the avatar or environment.”; “Properties of funny things coming into the film.”; “Found it very funny to have the skeleton, it gave nice picture of innovativeness and humor.”; “Building up something gradually would be interesting.”; “Imagine night club, vote for next song and video and interact with that.”; “Trivia game to vote answer with group.”; “Music videos are nice, that inspires me.”*

We also argue that the personal mobile phone as the interface guarantees each user equal share of the joint authorship, in contrast to systems relying on motion tracking where the audience members have uneven degrees of control because people closer to the camera have a more pronounced effect on the interaction [9].

4.3 Enticing interaction with public display

The use of large interactive displays has an established history in supporting collaborative and group-based activities. Primarily, they have been used to support various cooperative activities that occur within meeting rooms, classrooms, offices and other workplaces. More recently, researchers have begun to situate large displays within communal and more informal settings [4]. Large-screen digital displays are becoming increasingly prevalent in public spaces, but currently most of them are minimally interactive and are designed for one-to-many interaction [6].

As we already discussed in the introduction, Churchill *et al.* [8] found that people needed constant encouragement and demonstration to interact with the public display. Similarly, Agamanolis [2] has noted that half the battle in designing an

interactive situated or public display is designing how the display will invite that interaction. This means that a key issue is how to design the displays so that they invite interaction [2] and collaboration [19].

To entice interaction we employ the lottery mechanism, which according to our observations had a strong impact on the users’ motivation to interact. Paek *et al.* [15] has identified that as an incentive, a lottery could notify random participants that they have won a prize. Our test users agreed: “I think the idea of having a lottery to win a pizza or a beer in such a system is good” (13/0). Lottery had a clear effect on the social interaction, for when a winner was announced on the public display, it stirred lots of excitement: *“The excitement, what happens next, who wins the lottery”*. People were happy when their mobile phone indicated that they had won, raising their arms in the air, just like happy winners do, and then showing their received pizza or beer coupon to others nearby. However, it became clear that the lottery was at best in supporting role in comparison to the interactive content in terms of enticing interaction.

Brignull *et al.* [4] mention that one of the reasons for the initial reluctance to use novel public display systems may be that it is not clear to the members of that community how they can integrate them with their existing practices. Another reason may be that people can be self conscious and inhibited when required to do new things and act out in a public arena. We circumvented this problem by deploying the trusted personal mobile phone as the user interface. It allows anonymous participation in the multi-user interaction with a familiar device, making people invited and uninhibited to interact.

Pacing the activity is one important aspect of the interaction. Punctuated deadlines give the audience a chance to succeed or fail; the rest periods give them a chance to contemplate, celebrate, and prepare for the next moment of tension [12]. In the MobiLenin system such deadlines are determined by the voting intervals controlled by the server, whose rhythm was found appropriate: “The voting interval was sufficiently long” (10/2). We noted that the time of waiting for the results created a dramatic moment for people during which they strongly socially engaged with each other. This moment can be used e.g. to build up dramaturgy within the interactive art experience. A satisfactory feeling was perceived when the result showed that their choice was found right. On the other, hand some participants stated that there is also a risk of getting frustrated if your wish of choice does not match with the majority vote enough often.

When asked how long the interaction could go on, test users responded: *“As long as you get new information on screen, or is not repetitive.”; “At beginning when choices seemed to be wide enough, after a very short time one could know what are the different choices to make - knowing the spectrum, after that it became ok, I have seen it already”; “But if doing it again maybe after three times with same video it got a bit boring. So a new video might be good after second or third time or first time, I don’t know, but something new.”; “The content was ok for a first 10 minutes, but it was afterwards becoming boring.”* These comments reflect the importance of the novelty value of the interactive content: the user has to be able to anticipate “something new” at the point of interaction.

4.4 System design and implementation

We can identify a number of aspects in the design and implementation of the MobiLenin system which contribute towards the positive user experience.

Ease of use. Brignull *et al.* [4] state that it is important to provide an initial set of display-based interactions that are intuitive and can be easily and comfortably followed. Allowing users to engage with the display, without needing help or feeling self-conscious, is a key concern when situating displays in communal spaces. We used the standard UI paradigm of the Nokia Series 60 platform, to produce a simple UI with which the users are already familiar thanks to their everyday mobile phone use. The usability was further enhanced by the server controlling the state of the client to prevent any navigation errors. “The system was easy to use.” (13/1).

Transparency of what the system has to offer. It is important that audience members understand how their actions affect the game activity. They will not continue to participate in an activity if there is no immediately clear indication that they are affecting the game [12]. Sandin [21] states that in interactive systems it is vital that the participants quickly realise that they have control and understand what are the parameters of that control. In this way, the users can easily learn the simple relationships between their actions and the system itself. MobiLenin succeeds in addressing this challenge: “I felt it was clear from the beginning what the system has to offer me and how to interact.” (9/4), “The system gave me a clear picture of the outcome of the group vote.” (12/1).

Constant but light feedback. The popup notes triggered by the server onto the client UI were found very useful in maintaining the interaction: “I found the popup notes useful on the phone that indicated ‘voting on’ or ‘vote is processed’.” (12/0). We can conclude that for an interactive system such as the MobiLenin system, the guidance of the individual user through the interaction process and constant feedback from the system is crucial in order to keep the user hooked up and encouraged in the interaction. But this guidance must be simple and light, for which a personal mobile phone is a potent solution.

Multiple choices in interacting. While designing the system, we contemplated offering the users only with the possibility to vote for a gradual up/down change in the video, but thankfully we did not go for it: “6 voting choices in the menu were given - to have fewer choices would be better” (0/11). “It would have been more interesting to vote, if the system gave the chance to vote only for “up”, “stay”, “down” in order to influence the flow of the video” (0/10). The analysis of our video interviews shows that it is important for the user to be able to anticipate from the menu choices what comes next on the large display and that these choices reveal new aspects of the content - something new that holds a surprise value but also something that confirms what the user has anticipated: “*Seeing, if the thing that happened was the thing I voted for*”.

Music. Camurri *et al.* [5] describe how direct relationships can be established between certain parameters of music and the associations created by it. For example, a fast tempo is associated with various expressions of activity, excitement, happiness, potency, anger, and fear, while a slow tempo is associated with various expressions of sadness, calmness, dignity, and solemnity.

Loud music may determine the perception of expressions of intensity, power, anger, and joy whereas soft music may be associated with tenderness, sadness, solemnity, and fear. Certainly, the song “Ggogogo” used in the interactive music video by artist Lenin’s Godson is of positive, “good mood”, “easy to listen” nature while the tempo is rather fast, but not too fast. This leads to the question on how relevant music is for the overall atmosphere and user experience of an interactive entertainment system such as the MobiLenin system.

5. DISCUSSION

We believe that new and exciting forms of interactive art can emerge by further developing hybrid virtual interfaces such as the MobiLenin system. We combined the private GUI of a personal mobile phone with the public GUI of a public display into a real-time hybrid interface which fosters the social dynamics of co-located groups without distracting the user. The personal mobile phones also disperse control, allowing multi-user interaction with a single public display, thus empowering a group of users with the joint authorship of the multimedia art piece. The system also contains a built-in lottery mechanism as an incentive for interaction.

Experimental evaluation in the true environment of use showed that the MobiLenin system succeeds in enticing social interaction at both personal and group level, addressing several of the challenges identified in the literature. The users embraced the joint authorship, which resulted in high social activity among small groups of people. Similarly, the users enjoyed the lottery mechanism: the announcement of the anonymous winner on the public display stirred plenty of general excitement, which then erupted in someone’s personal celebration followed by congratulations from the group.

In addition to dispersing the control and facilitating the multi-user interaction with a single public display, employing personal mobile phone as the private GUI brings also other advantages. They are ubiquitous and as such remove the need for any additional, possibly application or service specific user devices. A personal mobile phone is the trusted device and it allows anonymous participation in a group activity, which both contribute towards people feeling invited and uninhibited to interact. Mobile phones also guarantee each user equal power in the interaction and provide a reliable return channel for delivering confidential user specific information back to the user.

Our study confirms that social involvement is much more important than technological involvement. While people are initially amazed at the technology allowing the interaction to occur, within 30 seconds they lose interest if the activity is not inherently entertaining [12]. Our test users commented that in order to keep their interest up in interacting with the music video for a longer time, the system would need to offer something new they have not seen before. Our conclusion is that the key lies in the production of content, so that the user is allowed with a sufficiently rich set of choices to choose from at different times and can anticipate “something new” at the point of interaction. One important issue in producing non-linear content is that the production might require more resources, since multiple tracks need to be produced of one and the same part.

5.1 Future work

The MobiLenin system can be expanded in different ways by adopting different content and modifying the script of the interaction. Other possible concepts include interactive storytelling, trivia and multi-player gaming, for example.

The MobiLenin system is scalable so that even large groups of people can interact with the public display and the content. We could ramp up the activity of the current setup into a much more versatile interaction pattern in a more dynamic setting of a live concert. Starting from simple majority votes for the next song to be performed, the interaction could be extended all the way to complex issues such as allowing the audience to interact with the parameters of individual instruments played by the musicians on stage.

The feedback channel provided by the private GUI of the mobile phone application allows addressing individual users or subgroups. For example, the system could ask only one fourth of the audience to wave their hands in the air, or to hug their neighbors, or to shake their hands, or to shout as loud as possible, for the purpose of triggering events full of surprises, something new that the participants are expecting from the interaction.

Further, the virtual interfaces of the private GUIs could be used for clandestine negotiations, but apart from the communications functionality, the virtual domain would still be unaware of the players' state of the diplomacy [10]. In such a constellation the system would allow different participants or even different groups of people to vote for different things or at different times. For example, users or groups would have to compete against each other or the interactive content would include role play characteristics. The system architecture would allow such scenarios since the server drives the voting mechanism and can handle dynamic menu contents even for different users at the same time.

In this paper we did not address service discovery, i.e. the user becoming aware and obtaining the external service or application (s)he is supposed to use. In our case the provider of the interactive art entertainment could advertise the service in its premises, together with instructions for downloading the application from a local Bluetooth service point or from an Internet page. Another technical issue we have yet to address is the scalability of the current implementation, which becomes relevant when we would like to include larger user groups.

We also did not discuss candidate business models. In our system users would have to pay for GPRS data when joining the voting. However, the amount of transferred control data is very small compared to e.g. browsing internet pages. We do not expect it to be a problem, however, as people are increasingly using data connection e.g. to browse the internet with their phone. Hence, they often pay a monthly fee for data access already. Further, mobile phones equipped with WLAN radios are starting to enter the market hence a pub could offer the proposed system as a free service in its WLAN hotspot.

5.2 Developing other interactive art concepts with the MobiLenin architecture

The MobiLenin system is a combination of multimedia art (interactive music video), public display, mobile technology and a simple server. We briefly discuss few factors promoting the

MobiLenin architecture as a good platform for developing other interactive art pieces.

1. Ease of use. Easy-to-use client applications on ubiquitous personal mobile phones are used for interacting with the art piece shown on a public display.

2. Flexibility. The server is controlled with simple scripts, which allow flexible tailoring of the application. Similarly, the Python scripts of the client application facilitate easy and flexible modification according to the application.

3. Modularity. Each component has well-defined interfaces and APIs. This allows for example replacing the current multi-track music video with versatile dynamic content whether it is a short movie with non-linear structure, a game or any other multimedia art.

4. Real-time control of clients with private return channel. The architecture allows real-time control of the client UI for the purpose of implementing well-defined dynamic HCI patterns for both individual users and groups. The private return channel allows the application to communicate privately with individual users, which can be utilized for various purposes.

6. NOTE

A video of the experiment described in Section 3 is available at http://www.leninsgodson.com/mobilenin/mobilenin_js_01.avi.

As soon as we have polished and packaged the source code for distribution, it will become available to the general public at the above mentioned website.

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