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Asynchronous Communication of Experiences in a Mobile Environment

by

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Abstract

In this paper we propose a method for capturing and representing experiences in an asynchronous experience communication task that takes advantage of recent developments in mobile technology, in particular sensing technology, tangible interfaces and augmented reality. The method's key aspects are the reduction of the context space to non spatial context, the allowance for expressive user-created experience representations, the automatic enrichment of experience representations with contextual information and the immersive presentation of experience representations to other users. Meanwhile we present a tool named *Graffiti* that implements the designed method and runs on a mobile consumer phone. We think the method introduces a new way of communicating experiences that allows for higher quality experience sharing both in terms of user satisfaction and accuracy of experience representation. A user study will be conducted to test this hypothesis soon after publication of this paper.

Key words: experience, mobile, graffiti, communication, context-aware interfaces, colour emotion, augmented reality, affective computing, tangible user interfaces

Acknowledgements

I want to give special thanks to Frank Nack who I spent many hours talking with and who was a great source of support and inspiration. I also would like to thank the people from IYouIt who created the source of our ideas, Abdo for providing his help and critique and Wouter and Bert for their efforts to maintain a healthy structure in the project.

The few remaining truths are graffiti, suicide notes, shopping lists.

Francesca da Rimini

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1. Introduction

Inter-human communication of experiences has seen major changes in the 20th and 21th century. With the support of modern communication tools, social networks have expanded from small networks, maintained in small local communities, to large world-wide social networks. Notably, as a result of the introduction of the internet and mobile technologies, communication now for a significant part takes place asynchronous in time and/or place. These indirect forms of communication, while increasing the range of a sender, typically have a negative impact on the quality of communication partly due to limited possibilities for encoding context in the message. Both external and internal context are central elements of experience [1] and their representation plays therefore an important role in the design of tools for experience communication.

In this paper we propose a method for capturing and representing experiences that (to some degree) fixes parts of the experience thus reducing the encoding problem and enabling a focused investigation of other parts of the experience. The central idea is to capture the representation of an experience as created by user A at time t_A in some local context C and to reconstruct this representation for user B at time t_B in the same context C, thus fixing the spatial context of the experience. Furthermore special attention is paid to provide the user with an attractive and intuitive system interface that allows for the smooth communication of expressive representations; attributes that we deem necessary for a good experience communication. This view is supported by [1] and by McCarthy & Smith [2], who emphasize the importance of sensory engagement in the establishment of experiences. The method involves the use of a self-devised mobile augmented reality system (or: a MARS) which is used both to allow for establishment of experiences in a natural environment, and to position a representation of a user experience on an exact location in a virtual space, thus creating an augmentation layer over the real world. The MARS is developed in the Android programming language and implemented on a consumer mobile phone with a tangible interface. The prototype is named after the metaphor that we employed for the system: *Graffiti*. As a proof of concept, the system implements models for automatic partial extraction of internal context from low level features of user-created experience representations (virtual graffiti), in particular the colours used in the representation.

We think that the proposed method introduces a new way of communicating experiences that allows for higher quality experience sharing, both in terms of user satisfaction and accuracy of representations, than existing communication systems.

2. Theory

2.1. Experience

The term 'experience sharing' is often associated with community-based recommendation systems for sharing recommendations regarding consumer products, tourist locations etc. [2]. For the scope of this paper this view is too limited and we need to arrive at a broader definition. For this it is necessary to have a closer look at the term 'experience'. As a starting point we take the definition of experience as given by Nack: '*the non idempotent alteration of the cognitive map and/or related cognitive processes of the one who has the experience, derived from direct observation or participation in an event or activity over a certain period (short or long term)'* [1].

From this definition it becomes clear that direct interaction with an event is a necessary factor in the establishment of an experience. This view is underlined both by McCarthy & Wright [2]who position the *'irreducible relationship between self and world'* as starting point for of an experience thus acknowledging the importance of sensory engagement, and by Jain [4] who defines an experiential environment as '*an environment where users apply their natural human senses directly to observe information related to an event'*. A second aspect of experience we want to mention and which is emphasized in the provided definition is its temporal and interactive nature: an experience changes over time in response to both itself and a dynamically changing context.

Nack observes three essential aspects that are related to experience and of importance for constructing representations of experiences: the *what*, the *why* and the *how*. The *what* stands for the *event* that is the basis for establishing an experience. An event is both a spatial entity as perceived by a person and a temporal entity having a start time and duration. Similarly [4] describes an event as *an object with time and space as its primary attributes*. The *why* stands for the *context* that is defined as the '*interrelated social and cultural conditions in which something exists or occurs*' [1]. A particular important distinction posed in the paper is the distinction between *external* and *internal* context. The external context consists of external sources such as objects, setting, characters and actions, while the internal context is based on an inner world model and influences the way we perceive the external context. Both contexts are necessary for establishing an experience. A consequence of the latter is that an experience is necessarily of a personal nature, a view that is shared by [2]. Finally the *how* stands for *presentation* which concerns the problem of how to establish an experience. We will come back to this later.

2.2. An Experience Communication Model

Based on the previous notions regarding the personal nature of experience, a logical conclusion would be that experience sharing simply is not possible. We quickly want to admit this and then leave it behind, since it is true for any form of inter-human communication. Sharing individual internal states with other beings is, at least in practical sense, impossible. Experience sharing should therefore be understood as the process of communicating experiences during which the introduction of noise is unavoidable. The challenge for an experience communication system lies therefore in eliminating as much as possible the factors causing this noise. In particular the system should be optimised to reduce noise that it is responsible for, namely the noise that is introduced on top of normal inter-human communication when people engage in temporal or spatial asynchronous communication of experiences supported by a communication system.

The process of asynchronous machine-aided experience communication can be described analogous to Shannon and Weaver's general communication model (Figure 2.1) as described in [5] as follows: The experience of user A is established (source). User A represents (encodes) his experience through the interface of the system (message). The system captures, analyzes and compresses the representation (transmitter) where after the experience is transported over space and/or time (channel). The encoded representation is reconstructed (decoded) to be presented (message) to person B (destination).

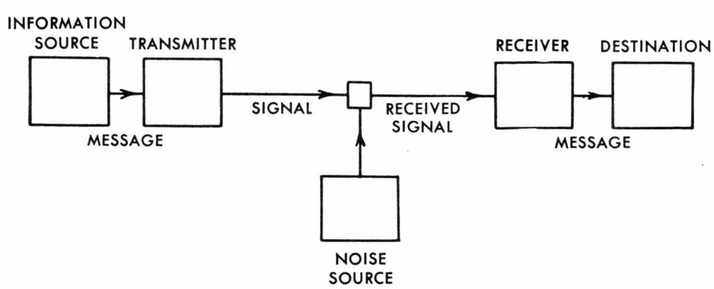

Figure 2.1 General communication model (Shannon & Weaver, 1948)

One variation on the model should be made to reflect the introduction of noise during the process of representing the experience. As mentioned before, one of the shortcomings of many communication tools is the limited means of expression that the user is provided with. Thus the communication of an experience is distorted both by noise introduced during the formulation or reading of a message as by the limited means that most systems have for encoding an essential aspect of an experience mentioned in the previous paragraph: the context.

A successful experience communication system should address these issues and provide the user with an interface that allows for free expression. Furthermore it should be able to encode the results of this interaction as well as the internal and external context of the experience as accurately as possible.

2.3. Experience Representation

Experience representation in an experience communication system is accomplished in two ways. First, the user that has the experience decides actively to communicate the experience by constructing an experience representation in a form that is processable by the communication system (e.g. a text message). In turn the system constructs a representation (bits and bytes) of the experience based on the representation provided by the user. This representation could possibly be further enriched with additional information related to the context of the experience.

2.3.1 User-Created Representations

To facilitate both the establishment and 'reliving' of experiences through the use of the system it is important to provide the user with adequate tools for telling his story. The previously mentioned importance of direct sensory engagement with the environment becomes apparent here. Singh & Jain name several essential characteristics of an experiential system including directness, intuitiveness, and allowance for perceptual analysis and exploration [7]. In particular they mention the superiority of visual interfaces above textual interfaces in this context. Nack points out that experiential systems often use narrative structures to create coherent, immersive and real-seeming worlds that reduce the outer context (real world) thus gaining some control over the user's experience. Interesting here is the parallel with the philosopher Dewey who writes in his book *Art as Experience* [8]: *'In art the forces that are congenial, that sustain not this or that special aim but the processes of enjoyed experiences itself, are set free. That release gives them ideal quality'.* In his view the ideal quality of artworks gives an artist the power to express purified real experiences that could not have been expressed by reproducing the real world alone.

Weiser uses the term 'calm computing' to describe the idea of a computer system that allows the user to fully concentrate on a task *'just like a well balanced hammer disappears in the hands of a carpenter'* [4]. For an experience communication system it is in the first place essential to be such a 'hammer' for the user and not an obstacle. The interaction with the system should therefore be natural, intuitive and immersive.

Moreover the user should be provided with artistic, visual tools to express the story of his experience in a way that is both understandable and immersive to other users as well.

2.3.2 System-Created Representations

The task of the system is not only to transfer user-created experience representations to other users but also to minimize the noise introduced due to the lack of context that is encoded within the representation. In [1] a distinction is being made between events and context. We want to simplify this view and regard events as part of an external context that is dynamically changing. The task of the system consists now of two parts, namely a relative 'easy' part being the capturing of the external context (which is not easy at all) and a hard part, namely the capturing of internal context.

Not surprisingly, most existing context-aware systems focus on capturing elements of the external context such as location, time, locations of friends or even weather conditions [9]. Modeling the external context of an experience can roughly be divided in three tasks: modeling the spatial attributes of the context, modeling the temporal aspects of a context and modeling the events that take place in the context. From these three, modeling time seems to be the least problematic. A representation of an experience can simply be encoded with the time of creation. Temporal relations between the several experiences can be modeled by placing them on a timeline or in a sorted list. Events on the other hand are much harder to model, since they typically are of a very complex nature, highly variable and rapidly changing over time. In [1] an approach to modeling events is sketched where the events are represented as minimal descriptive sets. For this to work in practice, one would need a unified semantics for describing the sets. The spatial context is hard to represent as well: one can describe a street, the size of a square or the architectural style of a building to a person, but to really 'feel' a place one has to be there in person. The Romans had a name for this phenomenon: *genius loci*, the guardian spirit of a place. The spatial context is in a sense more stable than a temporal context or an event in the sense that a place typically doesn't change much over time. Presenting a spatial context to a user thus can be accomplished simply by placing the person in that same context. Reconstructing events or time is naturally much harder or impossible simply because they are not around anymore to grab and show to the user.

Representing the internal context associated with an experience is hard, but essential for a proper evaluation of the experience. Modeling the internal context involves the representation of feelings (mood, emotions), intents, preferences, habits, character, and attention. Most of these are still very hard to realize in automatic systems. Statistical modeling of user preferences is arguably the most successful and has been put to practical use in multiple domains. Considerable effort has been put in the representation of emotions (affective computing) for example in the field of information retrieval (sentiment analysis from texts), computer vision (affective analysis from facial expressions), or in projects such as CARPE [11] that investigate the use of wearable sensors that measure temperature, blood pressure and heartbeat for passive analysis of mood, attention, condition, activity and health of users. Of particular interest for the system that we propose are efforts that have been put into the automatic mapping of colour to emotions.

2.3.4 Mapping Colour to Emotion

It has long been known that colours may evoke various emotions in humans. Indeed nearly every person has colour preferences and is able to associate colours with feelings. Most of the research in this area has focused on qualitative models for mapping colours to emotion. Typically a series of experiments is conducted where participants are asked to label colours from a limited set of colours with emotional terms. Heller assembled a large amount of colour-emotion associations this way [12]. Although the results of these experiments clearly point out that some relation between emotion and colour exists, this relation has turned out to be a rather complex one. Mathematical models for mapping colour to emotion largely have failed to produce satisfying results, especially when applied to multiple-colour configurations. Interesting results for single-colour mappings however have been obtained by Mehrabian & Valdez [13] who devised a quantitative model for mapping three attributes (hue, saturation and brightness/value) of colour sampled from the Munsell colour space to the 3-dimensional Pleasure-Arousal-Dominance emotional scale. Interestingly they found strong evidence for brightness and saturation having consistent effect on emotion, while the relationship of hue to emotion turned out to be weak.

Several studies have investigated the relation between so-called *colour emotions* and colour. A colour is the relationship between colour and the psychological response this colour invokes in humans. The term is somewhat confusing, since it concerns not only emotional terms, but semantic terms as well (e.g. heavy, dirty, light). Fairly accurate quantitative models for mapping colour to colour emotions have been developed, which are mostly independent of culture and sex [14]. Ou et al. [15] revealed a simple additivity relationship between single-colour and colour-pair semantics. This result has been verified by Sueeprasan & Srimork [16] who furthermore suggest that the simple relationship may well generalize to multi-colour configurations (such as will be used in our system).

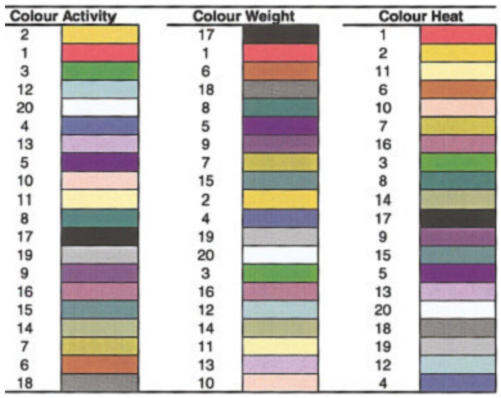

Figure 2.2 20 Colour samples ranked along the three colour-emotion factors (Ou et al., 2004a)

A quantitative model for colour emotions was developed by Nakamura et al. [14] who derived a set of formulas to map colours from the CIELAB colour space to twelve colour emotion scales. A relation was found between three colour emotion factors (warm-cool, potency, activity) and the colour attributes hue, brightness and chroma, respectively. Ou et al. [20] used 10 colour emotion scales from which three colour-emotion factors were identified (heat, weight and activity) (fig. 2.2) that agreed well with the factors (warm-cool, potency and activity) from [17,18,19]. Like [14] they found that these factors were largely independent of culture or sex. A quantitative colour-emotion model was developed which correlated well with [17,18,19] and a similar model of Xin et al. [21]. In a second study Ou et al. [15] found an additivity relation between single-colour and colour-pair emotions, a relation that however could not be applied to colour preference prediction (with a like-dislike emotional scale). In a third study Ou et al. [22] devised some models for predicting colour preference, one of them mapping preference to the three factors activity, weight and heat, and another one mapping preference directly to the CIELAB colour attributes lightness, redness-greenness and yellowness-blueness (L^*, a^* and b^*). No simple relation was found between preference and colour-pair emotions, but it was shown that colour harmony is an important factor for preference in multi-colour configurations.

2.4. Requirements

From the previous paragraphs the following requirements for an experience communication system can be derived:

1. The system should be able to capture and represent parts of the external context, such as location, time and events.
2. The system should be able to capture and represent parts of the internal context, such as user emotions or preferences.
3. The system should provide the user with means to record experience representations in an expressive and creative manner.
4. The system should provide the user with an intuitive, immersing and visual interface.
5. The system should be available to the user in his natural environment.

3. Method

3.1. Narrowing Down the Context Space

We'll start the description of our method with a crucial design step that we decided to take in order to reduce the complexity of the contextual representation task for the system. This step was born out of two notions: 1. something is best represented by itself, 2. there seems to be a particular strong relation between experiences and the physical, spatial context. While emotions, events or temporal context can to some extend be explained to a person, this seems to be much harder for the spatial context. To experience the 'spirit of a place' one has to be there, see it, smell it and touch it. This intuition connects well with the findings we presented earlier, namely that sensory engagement plays a major role in the establishment of an experience. Being somewhere, surrounded by a physical environment, allows for optimal interaction with this environment with all sensory organs.

These two notions brought us to the decision to reduce the representation task by abstaining from any representation of the spatial context and just keeping the spatial context 'fixed' during the communication process. In other words, to receive the message the recipient first has to visit the place where the message was sent. The disadvantage of this restriction is that our system now becomes an asynchronous and not anymore a distal communication tool. The advantage is a more controlled and thus higher quality representation of experience. Moreover, it allows us to focus on the task of representing other types of context.

3.2. The Graffiti Metaphor

A metaphor is '*a device for seeing something in terms of something else. It brings out the thisness of that or the thatness of this' (Burke, 1954).* Our system introduces or elaborates on several concepts such as augmented reality, context-aware systems, tangible interfaces and representing experience through virtual art, that are hardly or not at all integrated in people's daily lives (yet). The metaphor is a powerful tool for introducing users to such unfamiliar concepts and thus fits our purposes well. We have chosen to use the metaphor of *graffiti* since many attributes of graffiti map well to the features that we regard as important in our system. Like graffiti, the experience representations are location-bound, asynchronous communications, and can be creative, uncensored, opinionative, emotional, secretive and identifying (Table 3.1).

It should be noted however, as was pointed out by Saffer [23], that metaphors can turn out to be counter effective in three ways: 1) The characteristics of the familiar concept being compared to cannot be matched by the more abstract concept 2) The abstract concept has more properties than the familiar one does 3) New features may not fit an existing metaphor (scalability). Some of the pitfalls mentioned may apply to our metaphor too. The metaphor may for instance 'break' when a virtual graffiti is visible while it really should be obscured by an obstacle. The metaphor may also prevent users from exploring aspects of the application that are not typically graffiti-like, such as the annotation of graffiti with emotion tags, texts or pictures. Nevertheless, we think that the drawbacks are sufficiently compensated by the accurate mapping the graffiti metaphor provides from known concepts to aspects of the application that we find particular important to communicate.

Table 3.2 A mapping from graffiti attributes to application features

GRAFFITI		*APPLICATION*
Spraying	↔	*Creative & artisitic*
Illegal	↔	*Freedom*
Anonymous	↔	*Secrets & deep emotions*
Gangs	↔	*Identity & friends*
Tags	↔	*Marks & traces*
Wall writings	↔	*Opinion*
Morrison's grave	↔	*Genius Loci*

3.3. Capturing Experiences

One of the requirements for the system is that it should be available to the user in his natural environment. This makes a mobile personal phone, which people tend to carry around most of the time, a logical choice. Many of these phones nowadays have large, tangible displays (providing potential for an intuitive, immersing and visual interface), location sensors (essential for fixing the spatial context) and wireless internet connection (necessary for sharing experience representations). Also, people tend to have a personal connection to their mobile phone, which makes it an excellent device for capturing real experiences.

To facilitate the user to record his representation of the experience on the device in an expressive manner, we have created a user interface where the user can build an experience representation with artistic tools: a canvas, colours, and several paint brushes. An intuitive interface is provided where the user can create a graffiti by using his fingers.

Location sensors were used to record longitude, latitude and orientation. These recordings are necessary for fixing the spatial context of the representation. Furthermore the current time was recorded and encoded with the experience representation.

3.3.1 Capturing Emotions

It has become clear from earlier studies that a substantial gap exists between the low level feature *colour* and the high level concept *emotion* and that a simplistic model for mapping colours to emotions is probably bound to be inaccurate. An approach whereby a combination of different available low level features (e.g. shapes, gestures) together is mapped onto internal context may therefore proof to be more successful. As a starting point for more complex feature-emotion models, we have applied quantitative models for colour-emotion mapping to the user-created experience representation, the graffiti.

3.3.2 Colour Profiles

We have chosen to restrict the user to use five colours in a graffiti, thus acquiring a colour profile for every graffiti that is variable in colour only and not in number of colours. At the start of every graffiti session the user chooses an existing colour profile (or *palette)* from the profiles showed in the device screen. This conscious step of choosing a profile has the advantage that the users may be less tempted to choose colours at random, thus reducing noise in the measurements. During the process of creating the graffiti, the user can adapt the colour palette to suit his needs for expression, but always with a maximum of five different colours. When the graffiti is saved, the current colour profile is encoded with the graffiti and further analyzed.

3.3.3 Colour Analysis

The chosen colour profile is analyzed using the model provided by Ou et al. [20]. It should be mentioned that this model maps colour to colour semantics, and not to emotions. As we mentioned in the previous chapter, no good quantitative models exist for mapping multiple-colour configurations to emotions. To still arrive at a mapping from colour to real emotions we therefore have to make some generalization assumptions, the correctness of which we will evaluate in the user study. The following formulas, taken from Out et al., were used to calculate the values for the three main colour-emotion scales *activity, weight* and *heat* for every colour in the colour palette:

Colour activity

$$= -2.1 + 0.06\left[(L^* - 50)^2 + (a^* - 3)^2 + \left(\frac{b^* - 17}{1.4}\right)^2\right]^{\frac{1}{2}} \quad (3.1)$$

Colour weight

$$= -1.8 + 0.04(100 - L^*) + 0.45 \cos(h - 100°) \quad (3.2)$$

Colour heat

$$= -0.5 + 0.02(C^*)^{1.07} \cos(h - 50°) \quad (3.3)$$

Where *L*, a*, b*, C*, h* are CIELAB lightness, redness-greenness, yellowness-blueness, chroma and hue angle, respectively. The activity, weight and heat for the colour palette were calculated by taking the average of the five individual colours, which was motivated by the additivity relation found between single-colour and multiple-colour emotions in [15].

For colour preference two different models were used, taken from [22]. The first model (3.4) calculating preference on base of the colour semantics *activity(A), weight(W)* and *heat(H)*, the second model (3.5) calculating preference directly from the CIELAB colour attributes *L*, a** and *b**.

Colour preference (1)

$$= -0.1 + 0.84\,(-0.05 + 0.6 \tan(1.55A + 0.73)) - 0.18W - 0.14H \quad (3.4)$$

Colour preference (2)

$$= -0.65 + 0.03\left[(L^* - 50)^2 + \left(\frac{a^* + 8}{2}\right)^2 + \left(\frac{b^* - 30}{1.7}\right)^2\right]^{\frac{1}{2}} \quad (3.5)$$

The preference for the colour palette was taken to be the average of the values of all five palette colours. Since the additivity relation does not apply to the colour preference scale as well as it does to the other emotion scales, more sophisticated models are probably needed to get an accurate prediction preference of multi-colour configurations, including the effect of colour harmony on colour preference [22].

3.3.4 Mapping Preference-Activity to Pleasure-Arousal

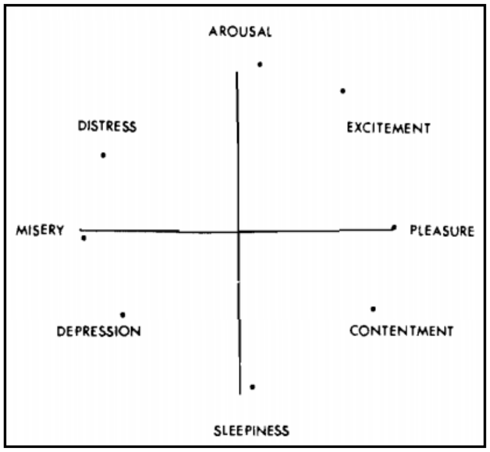

Figure 3.1 The two-factor emotional model Adapted from Russell (1980)

The values found were mapped to the two-dimensional Pleasure-Arousal emotional state model (fig. 3.1). The P-A model, introduced by Russell [24], is often applied in emotion research and has proven to be adequate for representing emotional responses to a wide range of environments.

To map de *activity* value of a colour to the arousal (= activity) dimension of the P-A model, we made the assumption that the perceived activity of a colour correlates with the activity value of the emotion invoked by the colour. This may seem a reasonable assumption, but it is not necessarily true. If the perceived activity is purely of semantic nature, the person perceiving the colour may describe the particular colour as having some level of activity in general. The actual emotional response to the colour does in principle not have to be correlated to this semantic value. Thus, with the side note being made that further research is necessary to clarify the relation between the two scales, we now proceed with describing our implementation of this model as an example of how internal context capturing could in principle work in our system.

We normalized the activity value of the colour templates to a value between 0 and 1. Based on this value, the colour profiles were assigned to a category on a 3-point arousal scale. The thresholds were chosen so that every category contains one third of all possible five-colour profiles (note that the activity scale is not linear):

Passive	←	*activity* < 0.39
Neutral	←	$0.39 \leq$ *activity* ≤ 0.52
Active	←	*activity* > 0.52

The same method was applied for the preference values and the corresponding dislike-like scale resulting in the following thresholds: 0.49, 0.62 for preference model 1 (3.4) and 0.37, 0.50 for preference model 2 (3.5). Both preference models provided by [22] were implemented to allow for performance comparisons. However, we strongly suspect that both preference models will not perform well on multiple-colour scales for reasons described earlier, and expect that a more advanced model incorporating colour harmony will have to be developed.

3.4. Creating the Representation

We have chosen to let the user as much as possible represent an experience directly and expressively by using a tangible interface with a graffiti tool to 'spray' a graffiti on the display using finger-input. Furthermore, the user is encouraged to take a picture of the spatial context that is relevant for the experience and place his graffiti directly on this picture. Expressive representations are facilitated by providing different ways of adapting the 'spray can' (e.g. colour, effects, size). When the user is finished he saves the representation and provides his name and a title for the graffiti. The user has also the possibility to place the graffiti anonymously, which we think will encourage people to share deep and secret experiences with the world.

The final enriched representation that is ready to be stored in the database contains now the following data:

- The timestamp
- The longitude and latitude
- The compass orientation
- The user-created representation (stored as a bitmap)
- The duration of the graffiti-making process[1]
- The gesture-activity (the distance that the finger of a user has travelled over the display divided by the total time the finger touched the display)[1]
- The colour profile with its activity and preference values
- The background picture
- The user name
- The title

3.5. Reconstruction

After the experience representation has been stored in a database it can at any moment be reconstructed for other users that visit the spatial context of the original experience. The reconstruction and filtering techniques used to present the experience representation to others is described by Mast [25].

[1] These values are stored, but not yet used for context analysis in the current implementation

4. Implementation

4.1. General Architecture

The graffiti application is implemented in the Android programming language and installed on the T-Mobile G1 consumer phone. This device has a touch screen, 3.2 Megapixel camera, gps, compass, accelerometer, and 3G network access. The mobile client is connected to an external database server[2] where graffiti representations are stored as well as colour profiles and user data. (fig. 4.1). The application uses a gps-service and has access to Google maps. Locally the application consists of four main modules: the user interface, the context manager, the user manager and the local database. For this paper only the user interface, the context manager and the local database are of interest.

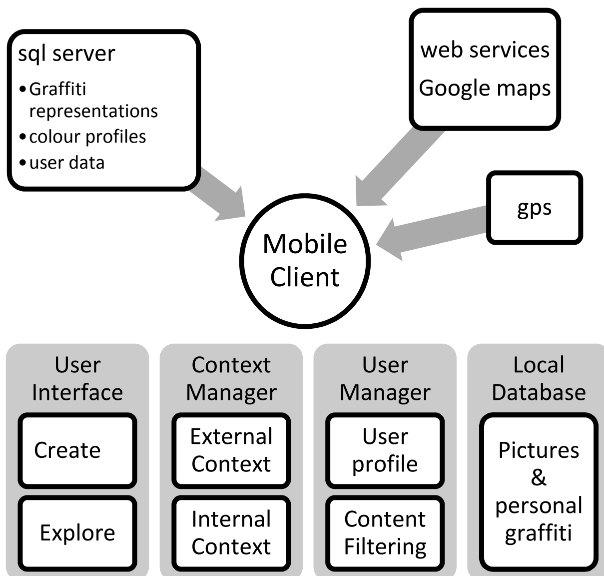

Figure 4.1 Graffiti: general architecture

4.2. The User Interface

The initial screen of the application functions as portal to either the *create* or the *explore i*nterface (the explore interface is described in [25]). For creating graffiti, the user has two options: either he can make use of graffiti tools to create a free drawing or he can type a text and modify the appearance of the text. The second option is implemented for evaluation purposes to assess user preferences with respect to free versus guided expression of experiences. After the user has chosen either of the two options, location and orientation are obtained from the context manager and a picture is automatically taken and set as background for the creation tool. From the

[2] The current implementation makes only use of a local database

Figure 4.2 User Interface a. Colour palettes b. Graffiti screen c. Font selector d. Text screen

colour palette selection screen (fig. 4.2a) the user chooses a colour palette that fits the current experience. The colour palettes (fig. 4.2a) were created partially using the online tool *Adobe Kuler* and partially generated randomly[3]. In the graffiti screen (fig. 4.2b) the user can create a free drawing using several brushes and effects (e.g. blur, emboss). In the textual mode (fig. 4.2d) the user can type text and modify the size, colour and style of the text. Most graffiti fonts (fig. 4.2c) were taken from the online source *1001freefonts.com.* After the user has created the graffiti he can save it and enter a name and title in a dialog screen. Overall a smooth interaction and navigation is accomplished by placing interaction buttons directly on the screen.

4.3. Processing and Storage

The colour palettes are analyzed in the context manager by converting the RGB colours to the CIELAB colour space[4] and calculating the activity and preference values as described earlier. The G1 device uses sRGB colours, which makes a conversion to CIELAB relatively straightforward (using the CIE standard illuminant *D65*). All non-media data is stored in local database (sqlite). Media (the graffiti and the background picture) are stored on a local sd-card.

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[3] One million palettes were created randomly, from which the five palettes with the highest and the lowest score for *activity* and *preference* were added to the application.

[4] An industrial standard, developed to account for the non-linearity in human perception of colours and colour distances.

5. Evaluation

A user study will be conducted in august 2009 among visitors of the *Westergasfabriek* area in Amsterdam, Holland.[5] The study aims to assess usability, system performance and user attitude and/or expectancies towards experience sharing (fig. 5.1) with regard to the two main aspects of the system: creating graffiti and reviewing/observing graffiti.

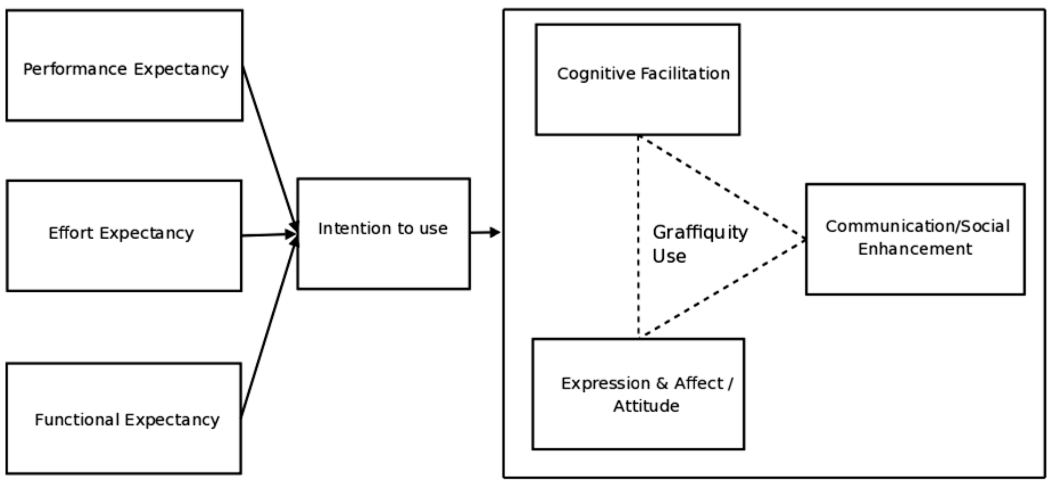

Figure 5.1 Model diagram for the user test (A. El Ali)

The questions are to be answered by users on a seven point scale (ranging from 'strongly disagree' to 'strongly agree'). A number of questions will address privacy issues, a subject that was not yet mentioned in this paper. For example:

> *I felt uncomfortable leaving a virtual graffiti in the world.*
> *I would feel offended if someone altered my graffiti.*
> *It bothers me if others can see my virtual graffiti when I am not there.*

It will be interesting to see how willing people are to share their experiences in the form of virtual graffiti and how comfortable they are with the idea that the system gathers and analyzes (very) personal data. The outcome of this user test will be important in deciding how to handle privacy issues and how to present the concept to the user.

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[5] The user study is devised and conducted by A. El Ali from the Human-Computer Studies Group, Institute of Informatics, University of Amsterdam.

6. Discussion

6.1. Summary

We proposed a new method for capturing, representing and communicating human experiences and devised the system *Graffiti* to implement this method. The key aspects of the proposed method are 1. Restrict the context space to be represented to the non spatial context thus reducing the complexity load for the system 2. Allow the person who has the experience to represent the experience immediately, in an expressive way using a tool that the person feels related to and that is intuitive, visual and immersing. 3. Enrich the experience representation by analyzing and encoding external and internal contextual information, either automatically extracted or explicitly provided by the user. 4. Present the enriched representations to new users in a space that is immersive and can be explored visually. The method was realised in *Graffiti*, a creative tool for expressing and communicating personal experiences. The first prototype provides a good functioning basic user interface as well as some modelling mechanisms for capturing and representing part of the external and internal context. The application can easily be extended with extra functionality (e.g. annotation tools, multimedia) and additional tools for context capturing and analysis (gestures, audio, text).

6.2. Future Work

We think that there is much promise in context-aware, ubiquitous applications such as *Graffiti* to help build better models of human experience in the future. Although the system was presented in this paper as an experience *sharing* tool, we envision the system to be both such a practical tool *and* a research tool for studying human experience in the future. In fact, we think that an effective tool for studying human experience in real environments necessarily must be such a two-sided tool in order to acquire the necessary amount of user data and be able to learn from it. Ideally such a system would continuously be improved with better and extended models for representing experiences, which would lead to more people using the system, which would lead to more data and feedback to learn from and so on (off course, when people would *really* start using such a system, it would quickly become the domain of commercial parties as well).

We want to conclude this paper by giving some suggestions for improvements and additions that we think the system will benefit from. To begin, a better model for colour-emotion mapping should be developed, which could for example be done by incorporating theory about colour harmony in the current models. Furthermore, an annotation system could be implemented where users explicitly convey their mood after the creation of graffiti. This information could be used to learn relations between colour profiles and mood automatically. An exciting addition would be to use a gestural interface for creating graffiti by exploiting the built-in accelerometer of the G1 (also common in other smart phones), which has been shown by Scheible et al. [26] to be a useful technique for creating immersive and creative interfaces. Instead of painting graffiti on the display, the user would provide input by moving the phone in the air and creating graffiti like he would do with a real spray can. The nature of these gestures might also provide valuable information about the emotional state of a person that could be used to build better models for capturing internal context. A more dynamic graffiti canvas could be designed, providing the option to users to add comments, annotations or even their own graffiti to existing graffiti. However, the system would have to deal with user rights (who are allowed to view or edit?) and representation issues for the canvas (is older graffiti still accessible, can canvasses be enlarged?). Users could be provided with the option to 'replay' graffiti, thus seeing the process of creating the experience representation as well. The system could be integrated with the context-aware system IYouIt, that has an existing user base and provides tool for modelling social context, and other context as well (e.g. weather conditions). Accuracy of the localization of the graffiti layer could be increased by adding computer vision techniques for recognition of background features (such as features of buildings) that would enable the system to exactly project graffiti on a background. Users could be given the option to annotate the graffiti with many more sources, such as audio, music titles, text, video, pictures, links and news events, which would make the context of the experience more clear to other users or could be used by the system for enhanced automatic analysis of the context.

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