Autopoiesic Content: A Conceptual Model for Enabling Situated Self-generative Content for Public Displays

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Abstract. The significant price drops in large LCD panels have led to a massive proliferation of digital public displays in public spaces. Most of these displays, however, simply show some form of traditional advertising, such as short commercials, animated presentations, or still images. Creating content that explicitly takes the particular location and surroundings of a space into account, in order to increase its relevance for passers-by, is typically infeasible due to the high costs associated with customized content. We argue that the concept of *autopoiesic content* (i.e., self-generative content) could significantly increase the local relevance of such situated public displays without requiring much customization efforts. As a sample application, this position paper outlines the concept and architecture of *Funsquare*, a large public display system that uses autopoiesic content to facilitate social interaction.

Keywords: self-generating content, public displays

1 Introduction

The concept of *Autopoiesis* stems originally from the field of biology, where it describes inherently self-sufficient organic systems that continuously regenerate themselves – such as cells[1] [10]. The sociologist Luhman later used the term in his system theory to describe how social systems continuously "create themselves" through communication within [9]. We believe that the idea of such self-sufficiency can also be used to shape future public display systems, by offering an economic way of turning today's often ignored large public display systems [12] into more appreciated (and more noticed) services. In the context of public display systems, *autopoiesic content* would be content that is not explicitly entered, but is instead dynamically assembled by individual displays, based on existing *content fragments*, a set of continuously updated *context streams*, and manually controlled *matching templates*. Content fragments may be text, multimedia (pictures, video, music), or even application controls.

[1] Contrast this with *allopoietic* systems that create things that are not part of themselves – such as a car factory.

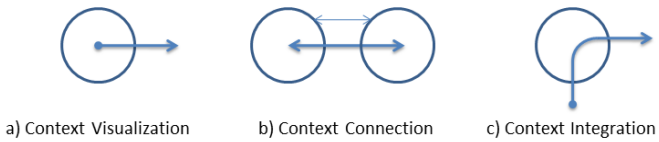

Figure 1: High-Level conceptual illustration of autopoiesic content classes. *Context Visualization* (a) creates content from local context information; *Context Connection* (b) creates content by exchanging/sourcing it with/from a related space; *Context Integration* (c) creates content by contextualizing external content with local context.

A set of carefully crafted matching templates would facilitate the recombination of such fragments with highly localized short-term and long-term contextual information, such as the current number of people in an area (and potentially their identities), the location of a display and current point in time (time of day, day of week, date), or any sort of environmental parameters (weather, mood, stock trends).

The idea of including context in display applications is hardly new. Well-known examples of such "context-aware" content are the many types of (commercially available) "ambient displays", e.g., colored orbs[2] showing stock trends, water fountains[3] indicating exchange rates, or lamps visualizing web site access numbers [18]. Our contribution lies in the identification of three distinct classes of such applications, as illustrated in Figure 1. The examples described above represent the simplest case (a), where the application simply *visualizes* existing context information. A more powerful concept (b) is the idea of *connecting* different display systems based on their individual context, and to exchange these contexts for display purposes. Finally, local context could be *integrated* with other, fixed information in order to create new content (c). These three cases will be described in more detail in the following section.

To make autopoiesic content a viable option for widespread content provisioning on public display systems, we envision a framework for content self-generation that will cover a large set of domains, thus facilitating application development. This position paper describes our initial set of three self-generative content classes (cf. Figure 1) that we believe represent the major application opportunities available in this space. We will outline prior work related to these classes and then briefly present an initial design of an application in this space called *Funsquare*. Funsquare is a public display app based on autopoiesic content that we plan to publicly field in summer 2011, and which we hope will serve as a blueprint for a more general autopoiesic content framework.

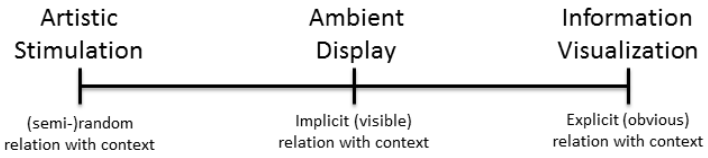

Figure 2: Continuum of Context Visualization Types.

[2] "Ambient Orb" by www.ambientdevices.com
[3] Koert van Mensvoort's "Datafountain" (2004), see www.koert.com/work/datafountain/

2 Classes of Autopoiesic Content Applications

We can classify applications that employ autopoiesic content according to the *type* of self-generative content they employ. We have identified three such types: context visualization, context connection, and context integration, which we describe below.

- **Context Visualization**: Applications create novel content by *visualizing current context parameters* (cf. Figure 3). The visualization can be (semi-)random, offering artistic stimulation rather than information transfer, or highly informative, by graphically depicting environmental factors using charts, simplified numeric values, and graphs. An intermediate form would be an "ambient display" not offering absolute figures but exhibiting perceivable regularities, e.g., color changes that visualize trends. Figure 2 shows the continuum of context visualization types. In context visualization applications, content is directly created from context, so no *content fragments* are used. Instead *matching templates* directly generate novel content from available *context streams*.
- **Context Connection**: Context connection is the act of creating novel content through the *exchange of content with related contexts*. A simple application would be a context-triggered "media space" that uses an audio-video feed to link two spatially separated spaces. In contrast to fixed media space installations, however, autopoiesic applications would dynamically create such an exchange, based on matching "context links." Context links can be triggered by identical or highly similar contexts (e.g., two country fairs in close-by villages), by detecting opposite contexts (e.g., linking a deserted plaza in a city with a busy shopping street, or a tranquil park with a hectic train station), by using static relationships (e.g., connecting "Yellowstone St." with a place in Yellowstone Park), or even semi-randomly (e.g., connecting cities with the same name in different states). The actually exchanged content can be video and/or audio feeds, environmental information (see context visualization above) but also user-generated content, e.g., postings to the original place that are also shown elsewhere. Context connections can be one-way or two-way. Figure 4 illustrates this concept. In context connection apps, *content fragments* are sourced directly from other, user-generated or autopoiesic content. *Matching templates* are used to match the *context streams* from different spaces to decide on which and when to connect.

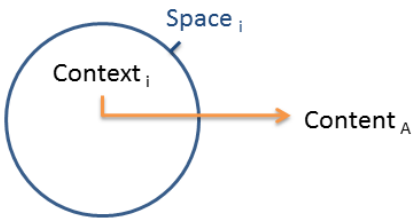

Figure 3: Context Visualization. Autopoiesic content C_A is generated through the transformation of local context C_i, gathered in a physical space S_i.

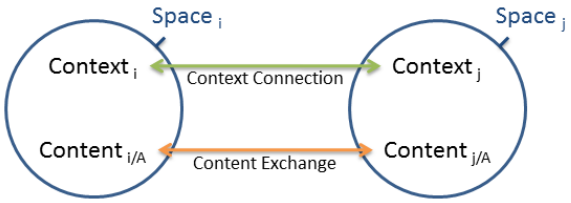

Figure 4: Context Connection. Autopoiesic content C_A is generated by exchanging, sharing, or sourcing content C_i from a related context C_j (and vice versa). The "connection" is based on matching or contrasting the two contexts.

- **Context Integration**: The last type of autopoiesic content uses *context matching to combine and integrate separate content.* In contrast to the two previous classes, content is brought in from an arbitrary number of potentially unrelated sources and then explicitly contextualized (transformed) through the combination with local context. One example may be the display of local bike shops (as listed in the Yellow Pages) in the context of a bike race, taking place in a part of the city. Another example of such an application is described in section 4 below, where we briefly present our planned *Funsquare* deployment. Figure 5 again illustrates the basic idea: existing *content fragments*, such as Yellowpages, city statistics, or weather data, is matched with local *context streams* using carefully crafted *matching templates* that can transform (contextualize) the content into contextually relevant information.

When observed in progression, context visualization is probably the best understood type (and most straight forward use) of autopoiesic content applications. Context connection will require significant efforts to properly match contexts, though some obvious static relationships (e.g., sister cities) can easily be exploited. Context integration will require a more in-depth integration of static content and matching templates, in order to create novel content from existing context streams. The following chapter will briefly summarize existing work in the field, in order to get a better understanding of the challenges involved in creating such applications.

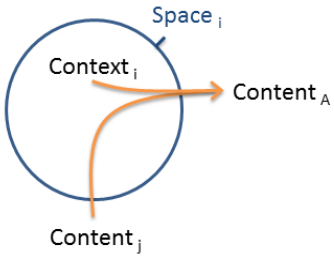

Figure 5: Context Integration. Autopoiesic content C_A is generated from various content sources C_j by contextualizing it with context information C_i drawn from a physical space S_i.

3 Related Work

The notion of autopoiesic content lies on the intersection of several active research areas, most notably public display content, media spaces, and context aggregation. We briefly summarize the most important work (with respect to autopoiesic content).

Content on public displays ranges from traditional content such as text [8] and images [5, 15], to more advanced content such as augmented reality [14]. Cityspeak [8] shows text messages sent from a mobile device or the Cityspeak's website. Each message is displayed in a different color allowing the installation to become a place where 'ephemeral graffiti' are created. CityWall [15] displays Flickr images of the place on a large multi-touch screen allowing people to more directly interact with the content. UBI-postcards [5] allow a social co-experience to be created by sharing virtual postcards. All three applications rely on user-generated material for filling the display with content, which offers limited control of what is being shown on the display. Also, these installations reflect their surrounding space in a very broad manner since messages can be sent from anywhere and their content does not have to address the space. Moreover, the Flickr image tags used in the CityWall project are usually not specific enough. In contrast to the above examples that display more traditional content, O'Shea [14] broadcasted an augmented video feed of the display's surroundings on a large public screen. People who were in front of the display were 'picked up' and 'carried' from the screen by a 'hand from above', or they were 'squished' and miniaturized. Although this type of content can be seen as self-generative, its use is rather limited as it does not go beyond amusing passers-by. Also, none of the mentioned work considered multiple content sources.

While research on public display content mainly informs *context visualization*, research on media spaces [1] can additionally inform *context connection*. A typical example of a media space is Jancke et al.'s work [6] that connects three public spaces within a single organization based on full duplex audio/video connection. In terms of context connection this can be seen as connecting content within the same context. In contrast to Jancke et al., the Telemurals system of Karahalios [7] actually creates new content from two audio/video feeds. The two video feeds are blended together in a single video and projected into the two respective sides. The single video image includes a materialized audio connection between the two connected spaces by displaying words used in the conversation. In the Visiphone project [7] Karahalios visualized sound levels within a single space and between two connected places as spiral dots on a sphere, where the color of a dot conveys origin of the sound, radius represents volume, and the distance between the dots represents pauses in sound. The Visiphone and Telemurals are good examples of context connection and visualization.

Another source of inspiration for *context visualization and integration* comes from context aggregation [4]. For example, Phithakkitnukoon et al. [16] used points of interest and people's movement patterns as context sources on a map to create an activity-aware map, providing information of the most likely activity within a location. On the other hand, Calabrese et al. [2] have combined an aggregated cellular phone trace with a list of selected events to estimate the movement of crowds. Similarly Quercia et al. [17] explored the correlation between social events and attendees' home locations as a strategy for recommending social events. Both point out possible context sources that could be used to create autopoiesic content.

4 FunSquare – A Prototype of an Autopoiesic Content Application

To explore implications from augmenting public displays with autopoiesic content we are currently developing *Funsquare*, an application to facilitate identity cognition [11], i.e., social interaction between strangers, acquaintances, and friends. Funsqaure is an example of a *context integration* application, i.e., it matches contextual data about the public display's location with 'fixed' data from a set of databases, and combines them into a stream of place-related "fun facts". Figure 7 gives an example output that combines the amount of WiFi data sent or received in that location with information about the energy necessary to bake a muffin. By providing conversational topics and becoming an unusual element of the place, Funsquare aims at stimulating socialization through 'triangulation' [2] – an effect where special features of the place act as a link between people.

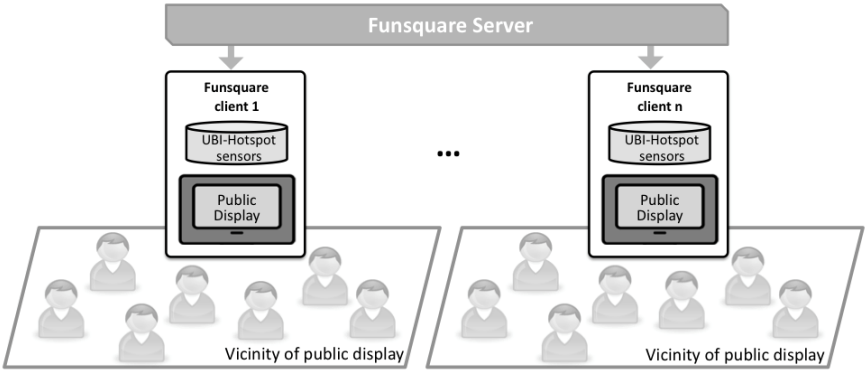

Figure 6: High-level Architecture of Funsquare

The high-level architecture of Funsquare is relatively straight forward, and is depicted in Figure 6. Each public display features a thin client application that facilitates the collection of *context streams* ("UBI-Hotspot sensors" in the figure), the displaying of fun facts, and optionally the collection of feedback from users. The creation of new fun facts based on local contextual data, as well as the overall management of *content fragments* and *matching templates* (i.e., the information used to put local context into a "fun" perspective), is done in a central server application. The server also allows for incorporating *global* sensor streams, e.g., the current weather situation, or occupancy levels of public parking lots, into displayed "fun facts".

All context streams (both global and those local to the public display) are represented as tuples f_i containing a textual description, a value, a measurement unit, a measurement type, and a timestamp. The main program uses a tuple space-like blackboard architecture in which context data is paired with different *content fragments* using fun fact *matching templates*, i.e., a matching process continuously compares the added context data with the pre-defined context templates in order to find matching measurements that can be combined into a new "fun fact". We are currently still in the process of developing the exact semantics of this matching process.

Figure 7: Early Design Sketch of the Funsquare User Interface

A mockup of the Funsquare user interface running on a public display is shown in Figure 7. We envisions a set of buttons that allow users to explicitly express interest in a fact, to leave a comment, or to download the fact onto a mobile phone with the help of a barcode that links to its RSS representation (not shown in the figure). The barcode mechanism could also allow for facts being shared through existing mobile social networking software installed on the user's phone.

Funsquare is a finalist of the 2011 UbiChallenge[4] and will be deployed in Oulu, Finland, throughout the summer of 2011. With the study we aim at assessing uptake, acceptance, and social impact of this type of applications in general, as well as investigating the feasibility of using autopoiesic content for such social applications. The evaluation will be done through field observations and by administering a "Sense of Community Index" (SCI) questionnaire [13] before and after the deployment. SCI questionnaires are a common tool for measuring the psychological sense of belonging to a community.

5 Conclusion

Public displays are becoming ubiquitous in our environment, yet their use is often limited by outdated or otherwise irrelevant content. To put these displays to better use we argue for *autopoiesic content*, i.e., self-generative content that reflects a display's surroundings and thus increases its relevance to passers-by. We categorized autopoiesic content into three classes: *context visualization*, i.e., content created from local context information; *context connection*, i.e., content created by either sourcing or exchanging content from/with related spaces; and *context integration*, where content is created by combining local context streams with existing content fragments using matching templates. In order to further explore the concept of autopoiesic content we are currently developing the Funsquare application, a context integration application that uses different context sources to create fun facts. We will deploy Funsquare in

[4] See http://www.ubioulu.fi/en/UBI-challenge

July-August 2011 in Oulu, Finland, as part of the UBIChallenge event, and plan to evaluate its effect on communities through observational studies and “Sense of Community” questionnaires.

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