Social Object Labels
Supporting Social Object Annotation with Small Pervasive Displays

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Abstract—This position paper introduces and discusses Social Object Labels, small pervasive displays for ubiquitous social object annotation. Taking an HCI perspective, it relates user experience problems with ubiquitous annotation described in the literature to a lack of dynamic information available to users and argues that small pervasive displays can address these problems by providing dynamic situated information that supports users before, during and after interaction. The paper describes three potential application domains for ubiquitous social object annotation and presents related scenarios to illustrate possible uses and interactions in concrete terms. It defines the design space for Social Object Labels with reference to related display concepts such as ambient displays and interactive public displays, and structures the defined space by discussing salient design aspects. The paper concludes with a summary and outlook on future research.

Keywords—HCI; Pervasive Displays; Ambient Displays; Interactive Public Displays; Ubiquitous Annotation; Pervasive Sociality; Social Object Labels; User Generated Content

I. INTRODUCTION

In a much cited paper taking stock of ubicomp research and discussing how the field can develop from here, Abowd [1] observes that many of Weiser's predictions have come true but some were not exactly accurate. As an example he cites inch-scale computers which were described as cheap, low-power, impersonal devices approximating active post-it notes [2] when in fact the most common inch-scale computers today are smartphones, which are far from cheap, high-powered and very personal to their owners. Reasons why the envisioned electronic post-it notes and "throw-away" displays [3] did not come true so far might include costs on the one hand and a lack of compelling use cases on the other hand.

With regard to costs, several factors currently play together that promise to make small display networks more economical in the future. The rapid adoption of smartphones, e-readers and other portable devices leads to higher production volumes and lower prices for small display components. Demand for wirelessly connected mobile and wearable computing devices accelerates the development and standardisation of low-power networking technologies [4]. New electrophoretic and electrowetting display technologies [5] consume less energy as they are bistable and only require power to switch state. Energy harvesting technologies [6], [7] can further reduce reliance on traditional external power sources such as mains or batteries and have already been shown to draw sufficient amounts of energy from wireless mobile interactions to transfer data and update e-ink displays [8]. Together, these factors promise small display networks that are economical to deploy and maintain as they don't require cabling and can run on batteries or ambient energy sources for extended periods. Commercial applications of such low-powered displays are already being explored, e.g. as electronic shelf labels [9], digital signage [10], smart luggage labels [11] and electronic badges [12]. They promise to fulfil Weiser's vision of "many, many displays" [3] in the near future.

With regard to use-cases, this position paper discusses an application for inch-scale pervasive displays as interactive Social Object Labels (SOLs). The idea of SOLs resonates with Weiser's vision of inch-scale displays as "electronic postit [sic] notes stuck to things" [3] and frames it in a particular application context. SOLs combine ubiquitous annotation, which involves attaching digital information to physical objects and places [13], with social concepts from the World Wide Web such as commenting and rating. They are based on the idea that conversations and personal links tend to develop more naturally around social objects which provoke and maintain interaction between humans [14], [15], [16].

In contrast to place-based messaging systems such as Stick-e Notes [17], Place-its [18], DropPicks [19] and Beam-Its [20], which appropriate and augment the idea of post-it notes to attach digital memos or resource links to locations, SOLs support social object annotation where content is not generic but topical, where the place or object does not provide a vague locative context but is the actual subject of discussion and where notes are not addressed to an individual or group but become part of an open discourse.

The next section explains the motivation and rationale for using small pervasive displays in the context of ubiquitous annotation. Following sections describe concrete application scenarios that illustrate possible uses of SOLs in various domains and then define and structure the design space with a view to mapping out potential areas for research.

II. BACKGROUND

Current applications of ubiquitous annotation typically deliver content to mobile devices through location based services, where information is delivered according to a user's geographic location, or through physical markers (e.g. 2D barcodes, radio frequency tags) which can be scanned by users to gain access to digital content and services. While the
Pervasive displays attached to physical objects or places can address many of these problems. They can provide dynamic information about an object before interaction takes place, enabling potential users to make an informed decision about their engagement. They also can provide dynamic feedback during the interaction, helping users to better understand interaction sequences and take appropriate steps in error conditions. Finally, they can show a trace of the interaction in the physical environment to confirm and document content submissions. We hypothesise that these advantages can improve the user experience of pervasive service interaction in general and of ubiquitous social object annotation in particular.

The following section describes three use case scenarios that illustrate how SOLs can promote engagement and support interaction in various application domains.

III. APPLICATION DOMAINS

Social object annotation is a generic concept that can be put to use in a wide range of application domains. This section briefly discusses possible applications in cultural heritage, retail environments and public consultation. For each of these we briefly discuss how social object annotation fits into the problem space and provide a scenario of use that illustrates the use of SOLs in concrete domain specific terms. Scenarios of use are a well-established method in user-centred design [39]. They are used to establish a shared understanding among designers, developers, users and other stakeholders involved in the development of new technologies and systems. By describing how technologies might actually be used in a concrete context, they help to make explicit what otherwise might be a difficult to grasp set of concepts. Scenarios evolve during the development process as they are increasingly informed by user research, however, an initial version without direct user consultation can be used to ground the design. The following paragraphs present such initial versions of use scenarios that illustrate how SOLs might be used in a museum, in a supermarket and at a public construction site.

A. Cultural Heritage

The cultural heritage domain has long been a test bed for novel technologies, especially in the context of audience engagement. Largely funded by public money, this sector is under pressure to demonstrate its relevance and contribution to society. As Hawkey [40] points out, the goal of many museums is participation, which can take different forms, including simple feedback, voting, collecting ideas and even contributing directly to a museum’s exhibits and interpretation. The literature describes a range of research projects involving ubiquitous annotation in museums, including ArtTraces [41], which enables museum visitors to take digital notes of their experiences and share them with others, QRator [43], which enables users to add their own commentary to museum exhibits and read the comments of others, and a system developed by Hsu & Liao [31] where users can comment on exhibits and share them on their preferred social network.
Scenario: Social Interpretation in Museums

Miles, a self-professed culture vulture living in London, is in the Tate Modern to see a newly opened exhibition on abstract expressionism. Walking through the gallery, he stops in front of a large Jackson Pollock canvas which prompts associations of city lights in him. Reading the image label, he notices the SOL next to it indicating 37 comments for the artwork. Curious to find out more, he touches the NFC symbol on the display with his mobile, which brings up a list of visitor comments on the device screen. Miles reads the comments and although he is annoyed by the large proportion of trivial messages he thinks that overall they provide a nice contrast to the professionally written museum label. He hits the Add Comment button at the bottom of the list and submits his own comment describing the effect the picture has on him.

B. Retail

Retail is another promising application domain for social object annotation, as the ubiquity of online product rating mechanisms and the rapid take-up of physical "Like" buttons [22] and "Check-in" marks [23] by retailers has shown. In a discussion of economic perspectives of the Internet of Things (IoT), Fleisch [44] identified user feedback and the value organisations can derive from it as one of the key "IoT value drivers". A mobile system based on this idea [27] enables social recommendation and discussion of products based on scanning their barcodes with a mobile device. Retail is also the only domain with experience of using small pervasive displays on a large scale - in the form of electronic shelf labels. Empirical research on the impact of electronic shelf labels [45] has shown that e-ink displays grab customers' conscious and unconscious attention, with 34% of participants confirming that they consciously noticed the dynamic display. It also showed that messages on the electronic label can influence buyers' brand associations and buying intentions. Perhaps most importantly for retailers, the study showed a "dramatic" improvement in sales for electronically labelled products.

Scenario: Local Product Recommendation

Highland, the foods company, is bringing a new breakfast cereal to market. They have arranged promotions with a major supermarket chain where the product is given a prominent shelf position and offered at a reduced price. To find out what people in different parts of the country think about their new breakfast cereal, Highland has provided each supermarket with a SOL to be placed on the shelf edge next to the product.

Jane is out shopping. Pushing her trolley past the Highland breakfast cereal promotion, she recalls the ads she’d seen on TV the evening before. Jane notices the SOL attached to the shelf indicating seven comments. Curious to find out what other people think of the new product, she touches the NFC symbol with her mobile and reads through the comments. While there are some mixed messages by other shoppers, she decides to make up her own mind about the new breakfast cereal and puts a box into her trolley.

C. Public Consultation

A third potential application domain for social object annotation is citizen consultation by local governments on issues of public interest. Schroeter [28] developed a system that engages citizens in the consultation phase of urban planning projects based on large public displays passers-by can post their opinions to via text message and Twitter. Taylor and colleagues [29] developed a public voting device to foster civic engagement in a disadvantaged community where residents can vote on questions posed by local representatives by text message or by using buttons on the device itself. Empirical studies suggest that both systems were successful in encouraging engagement and reaching segments of the population difficult to engage by other means. Furthermore, residents seem to appreciate them as attempts by local government to reach out and seek their views.

Scenario: Public Consultation

Sally and Sid stroll along the beach front in Brighton. While there are some mixed messages by other shoppers, they come across a large notice board with information about the planned Brighton i360 tower. Like most people in Brighton, they know about this controversial development project and have strong views about it.

Sally and Sid did not go to the public meetings where the project was discussed and did not respond to calls in the local newspaper to send in letters on the topic. However, standing on the very site where the planned tower is to be built, they both feel a new urgency to contribute to the discussion. Sally touches the SOL with her mobile to bring up comments left by other passersby. After skimming through some recent comments, they jointly formulate their own message and submit it. Sally and Sid both get satisfaction out of the SOL counter ticking up upon their submission, knowing that they finally made their point about the new development.

While one can imagine many other use contexts for social object annotation, the application scenarios discussed above illustrate the potential benefits of SOLs in various situations.

IV. DESIGN SPACE

This section relates SOLs to similar display concepts such as ambient displays and interactive public displays and then identifies particular characteristics that delineate SOLs from these display concepts and present particular design challenges.

SOLs are meant in first place to augment a physical object or space with digital information and not to compete with them for the user's attention. As such, they derive much of their underlying philosophy from key ideas in "calm computing" [46], including targeting users' peripheral attention to provide awareness information without increasing cognitive load. In this sense, SOLs qualify as ambient displays in that they aim to "require minimal attention and cognitive effort and are thus more easily integrated into a persistent physical space" [47]. They also qualify as peripheral displays in that they are "ubiquitous computing devices that give information to a user without demanding their full attention" [48] and as glanceable
displays in that "interpreting information on [them] must be very quick and easy" [49].

SOLs equally qualify as interactive public displays in that they are typically installed in public or semi-public environments and offer some way to interact with them. Because SOLs are pointless if people don't engage and interact with them, they share many of the challenges researched in the context of interactive public displays, such as attracting potential users' attention, communicating interactivity and supporting interaction at every stage from first engagement to final disengagement [50, 51, 52, 53, 54].

There is considerable overlap between many of these display concepts, e.g. glanceable displays typically are peripheral displays, both can be ambient displays, which may be public depending on the environment in which they are deployed and interactive depending on their affordances. Rather than defining distinct types of devices, these labels reflect specific problem spaces, design goals and research perspectives which set them apart from each other.

The same holds for SOLs, which come with their own problem space and design goals. There is a key design tension in SOLs between not diverting attention from the object they relate to and encouraging engagement from passers-by. While the former demands blending in with the environment and addressing users' peripheral attention, the latter relies on being conspicuous enough to inform and engage users. In addition, SOLs have a set of characteristics not present in that particular combination in other displays:

- They relate to a specific physical object or place: The information displayed on a SOL relates to the specific object or place it is "anchored" to [13]. This singular relation eliminates the need to explicitly associate information with a context and thereby reduces cognitive load.

- They are co-located with the object or place they relate to: SOLs are attached to, or next to, the physical object they relate to. Presenting information in close relationship with the anchor object increases its spatial deixis and reduces cognitive load, physical effort and errors when browsing and editing annotations [13].

- They have mechanisms to create content in-situ: While in-situ content creation can limit its richness, completeness and reliability due to practical issues (e.g. limited dwell time, awkward text input, lack of available resources), it can increase the expressiveness, liveliness, authenticity and relevance of content [55].

- They are driven by user-generated content: While ambient displays usually visualise contextual or machine generated data, and the majority public displays show professionally created content in a (1:n) communication model, SOLs are driven by user-generated content in an (n:n) communication model.

While some of these characteristics are shared with other pervasive display applications, the combination of all four and their format as small peripheral displays set SOLs apart from other pervasive displays described in the literature.

V. Design Aspects

This section describes salient design aspects for SOLs that help to structure the design space and provide a reference for its systematic exploration. Reflecting the large overlap between SOLs and related pervasive display concepts, many of the design aspects discussed in this section are synthesised from design space analyses, design heuristics and taxonomies for ambient displays and interactive public displays [56, 57, 58, 59, 60, 61, 62, 63]. While these typically don't cover aspects relating to in-situ content creation, they place great emphasis on awareness, attention and, in the case of interactive public displays, engagement and interaction, which makes them highly relevant in this context. In addition to shared design aspects, this section also discusses content-related design implications particular to SOLs.

A. Content-related design aspects

Attribution: the level to which content can be attributed to users. User-generated content can be stored and displayed without any link to its author; it can be technically linked to a specific but anonymous user ID; or it can be linked to a fully developed users profile. The kind and level of content attribution impacts on ease of engagement as it determines whether users can submit content anonymously or need to register and log in first. Attribution also impacts on moderation as users are less likely to post inappropriate content if they can be personally identified. Furthermore, attribution can impact on the feasibility of advanced functionality such as enabling users to edit/revise their contributions or to develop a profile/history.

Openness: the level to which content is openly available or tied to a specific system or location. From a technical perspective, this includes whether the system uses open formats, integrates with other systems or makes data available via an API. From an interaction perspective, this aspect includes "tetheredness" [64], i.e. whether users need to be co-located with the display to create/access content or alternatively can create/access content remotely.

Moderation: how user-generated content is monitored, filtered or edited before it is shown on the display. Apart from the distinction between pre- and post-moderation, there are numerous approaches for content moderation including automated content filtering, professional moderation by content editors and crowd-sourced approaches where users can report or hide inappropriate content. This aspect impacts on the user experience of both, reading content (e.g. being confronted with offensive content) and creating content (e.g. immediacy with which content shows up). It also can impact on adoption as host organisations may be bound by legislation or codes of practice concerning the content displayed on their premises.

B. Presentation-related design aspects

Information encoding: aspects relating to representational fidelity [59], level of abstraction [56], [60] and consistency and intuitiveness of representation [57]. Using a broad definition of the term "display" that extends to "non-display displays" [3], this aspect also includes the modality addressed by the display [56, 60, 63] (although actual designs might be limited by practical constraint and/or social norms).
**Information density**: the number of discrete information items presented by the display [59]. This can refer to both, different information sources and/or different types of information that may be displayed together, such as for instance user-generated comments, ratings, meta data, static information or calls to action. Information should be relevant [56], useful [57] and "just enough" [57].

C. **Interaction-related design aspects**

**Ease of engagement**: the level to which users can spontaneously interact with the display [61]. Factors in this context include technical inclusiveness (e.g. required hardware, software, network access), required prior knowledge (e.g. familiarity with scanning markers) and necessary preparatory steps to initiate the interaction (e.g. device setup, reading instructions, login). While it is generally desirable to lower barriers to engagement, there are internal design tensions in this aspect (e.g. newer technologies might be easier to use and reduce the need for preparatory steps but at the same time might only be supported in the latest generation of mobile devices which reduces technical inclusiveness) as well as tensions with other design aspects (e.g. anonymous contribution without the need to log in is more direct but likely to require more moderation).

**Control**: the level of control users have when interacting with the system. This includes afforded interaction [49], both in terms of the range of available functionality (e.g. can users edit content, reply to messages, create a profile?) and input granularity (e.g. do users select predefined options or can they enter free text?), as well as visibility of state [50] (e.g. does the system give appropriate feedback to support effective use and recover from errors?). This aspect not only impacts on the range of potential applications but also on acceptance as users might not engage if the system does not offer required functionality or fails to give appropriate interaction feedback.

D. **Environment-related design aspects**

**Information integration**: how the displayed information integrates with other information at the site and whether it duplicates information already present in some other form [58]. This aspect not only impacts on the usefulness of the displayed information but also determines how easy it is for users to associate the displayed information with its anchor object and take advantage of spatial deixis [13] in commentary.

**Obtrusiveness**: the level to which the display obtrudes upon users attention, i.e. how prominent or peripheral it is [56], [57]. Factors in this context include display size [62] and aesthetics [56], [57], [58], [59] which both influence how well it blends into the environment or stands out. Obtrusiveness is not a discrete quality of the display itself but must be considered in the context of a specific environment, which may have certain style conventions or constraints.

**Robustness**: how robust the display is with regard to deployment in public and semi-public places. This includes security aspects such as protection from vandalism and theft [61] as well as maintenance aspects such as the amount of regular service the system requires [61]. Robustness has design implications for a range of other aspects as it depends not only on hardware and technology choices but also on software architecture and functionality.

VI. **SUMMARY AND CONCLUSIONS**

This position paper has introduced a new application for small pervasive displays as SOLs. It has positioned SOLs as a display concept close to Weiser's original vision of electronic post-it notes attached to physical objects and places [3] and discussed both, technical developments and emerging social concepts of ubiquitous annotation, to highlight their potential and timeliness. Based on a discussion that related user experience issues with current implementations of ubiquitous annotation to a lack of dynamic in-situ information available to users, the paper has argued that SOLs can address these problems by providing users with relevant information before, during and after interaction. It has described possible applications in cultural heritage, retail environments and public consultation and presented use-case scenarios in each of these domains. With a view to mapping out potential research areas, the paper has defined the design space for SOLs with respect to related display concepts and discussed specific design aspects related to in-situ content generation, information presentation, interaction and integration with the environment. It also has identified design tensions, such as SOLs needing to be conspicuous enough to engage users but peripheral enough to not unduly divert users' attention from the object they relate to, which are of particular interest for future research.

**REFERENCES**


