
Leaky Objects: Implicit Information, Unintentional Communication

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Abstract

This paper introduces the concept of *leaky objects* to describe this phenomenon in which shared objects unintentionally reveal implicit information about individual or collective users. This leaking of implicit information changes our individual interactions *with* objects to *through* objects, enabling expressive communication and ambiguous speculation. The aim of this paper is raise awareness of this phenomenon through an ongoing autobiographical design probe in which remote interpersonal communication through a connected object is being explored, and raise questions regarding the potential implications for designers.

Author Keywords

Implicit interaction; Internet of Things; interaction design; autobiographical design; connected home

ACM Classification Keywords

H.5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

Introduction

Many consumer based objects and devices are designed for shared use or ownership, or are situated in shared contexts. These direct and indirect interactions of objects with multiple users affords the development of

a common ground in which interpersonal expectations and interpretations emerge. I propose the notion of *leaky objects* to describe the phenomenon in which shared objects unintentionally reveal implicit information about individual or collective users. Leaky objects results in interactions *with* objects being transformed to interactions *through* objects as implicit information enables expressive communication and ambiguous speculation.

In this paper, my exploration of leaky objects is focused on consumer-based connected objects, physical things that are networked to either the internet or each other in a home environment. First, I describe two categories of connected objects and review their associated information, interactions and unintended consequences. Second, I introduce an ongoing autobiographical design probe that bridges these categories and in which remote interpersonal communication through a connected object is being explored. Lastly, I reflect upon the resulting insight and discuss some potential considerations for leaky objects.

Related Work

Many consumer-based Internet of Things (IoT) devices fall into two paradigms of user-device interaction: user *with* a device and users *through* a device.

User with a device

This paradigm of user-device interaction is often the remote control of a technologically embedded object from a portable application or voice-based interface [6]. This control-based model highlights the interaction of a user *with* a device. While multiple users can interact with a single device, these interactions are usually asynchronous, thus designed as individual user

flows. Typical scenarios include the presentation or monitoring of explicit information such as the current status or associated historical data of a single object. Many commercial IoT products and solutions within this paradigm emphasize efficiency and automation by allowing the user to dictate the overall purpose that an artifact autonomously executes [5]. Corresponding concerns of these commercial devices are issues of security and privacy relative to external and unknown entities. By contrast, speculative projects such as Uninvited Guests by Superflux investigate the social implications of this interaction paradigm in connected objects, and highlight resulting frictions between humans and machines as user agency is challenged [9]. Although commercial products and speculative projects elevate differing potential problems, i.e. an unknown use of collected information versus an unintended response to the collection of information, they similarly concern explicit information from clearly defined interaction modalities.

Users through a device

The interaction of users *through* a device employs a threshold-based model in which novel objects are intentionally designed for remote communication, or a medium for expressions and impressions as described by Janlert and Stolterman [6]. While interactions can be synchronous or asynchronous, most often each user or location possesses one object from a family of connected objects. For example, the commercially available the Good Night Lamp incorporates a master-slave relationship in which the status of the master lamp controls the status of unlimited slave lamps. The on or off state intends to communicate presence or availability of the owner of the master lamp to the owners of slave lamps [2]. Other examples such as

Chat Technical Implementation

The prototypes use an Arduino Yún to send the sensor statuses to a real-time Firebase database. A custom web-based (HTML and JavaScript) chat interface integrates displays status upon text based request.

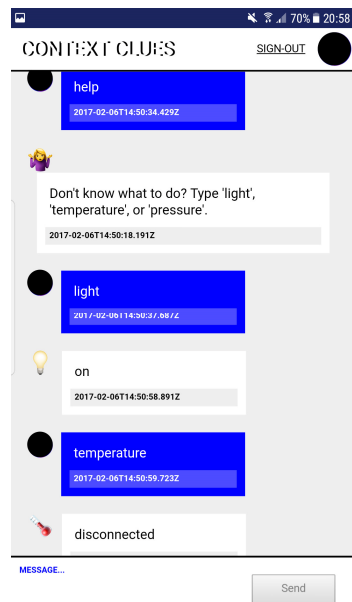


Figure 2: Chat interface as viewed on mobile device (original project name was Context Clues).

Feather, Scent and Shaker by Strong and Gaver aim to avoid the explicit symbolism suggested in the previous project, and instead offer the potential of expressive communication in which moods and emotions are intentionally loosely defined [8]. As pointed out in the previous example, an asymmetry of interaction exemplified in Feather and Scent, and I propose in the Good Night Lamp, could potentially be frustrating when an expected response by one user is not enacted by another user [8]. Furthermore, implicit communication can develop explicit meanings such as "thinking of you" or "I am okay" depending on patterns of use and intentions in users, thus equally embedding meaning in non-use or unknown technological malfunction [1].

Design Probe

Motivation

The autobiographical design probe that prompted the notion of leaky objects, was driven by a desire to communicate *with* shared objects about my partner. Following a recent international relocation for my academic employment, he is subsequently unemployed with a contrasting flexibility in his daily schedule and immediate physical location. While I have regular working hours in a consistent environment, his routines more frequently vary and are often spontaneously driven. This variability shifted the nature of my daily thoughts about him from specific inquiries into known events to general curiosities about possible happenings and overall well-being. For example, when he was previously working, I would inquire about a deadline status, presentation result or colleague interaction. Whereas now, I wonder if he is awake, at home or around town. The former often explicitly elicited a lengthy dialogue, while the latter only necessitates a brief response.

Therefore, upon reflection of this change in communication content and flow, how might our method of communication correspondingly be adapted? Instead of directly communicating with each other, could we indirectly communicate with things about each other? What information already exists from our interactions with objects? And is this derived implicit data a viable form of communication?



Figure 1: Diagram of sensor locations in our studio apartment. A photocell (remains) is within the floor lamp (1), a soft potentiometer (removed) was tried in various couch locations (2), and a temperature sensor (removed) was above the stove (3).

Design

The first prototype consisted of a custom web-based chat application in which the status of three sensors embedded within our studio apartment could be remotely checked. The sensors included a photocell light sensor attached to a floor lamp shade, a temperature sensor above the stove and a pressure sensor within a couch cushion. Their locations were chosen based on mutual patterns of interaction we acknowledged to have developed within our new apartment, and perceived intersections as defined by Odom and Wakkary [7] with particular objects. For

Powerswitch Technical Implementation

The custom powerswitch uses a 5V relay module connected to an extension cord to switch off and on the power, thus flickering the floor lamp.

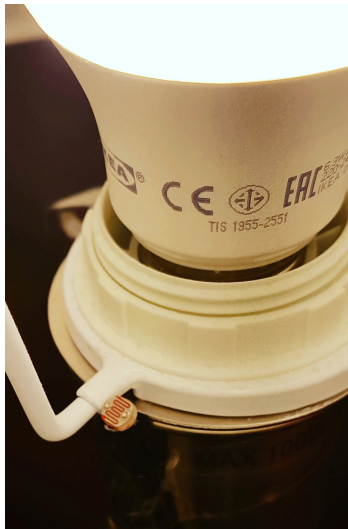


Figure 3: Photocell taped to floor lamp.

example, due to limited natural light, the floor lamp is always on when either one of us is home, implicitly indicating presence. A temperature increase by the stove usually suggests cooking, and pressure on the couch most likely implies a prolonged stationary condition leading to infer the other is reading or online. While the initial prototype provided sensor data upon request, it was not formally tested as a viable form of communication as the interaction felt overly one-sided in favor of the person requesting information.

The second, and current prototype, narrows the project scope of interactions to the floor lamp and aims to equalize the power imbalance between the two user types. While maintaining the chat interface and sensor, a powerswitch is being added to the lamp so that whenever the light status is requested, the power supply is briefly switched off, causing the light to flicker if already turned on. While the interactions with a preliminary lab-based prototype have been investigated, the in-home prototype is currently being implemented during the writing of this paper. Nevertheless, the intent of appropriating [3] a powerswitch into an awareness indicator of the remote user, has already transformed our discussions of the probe from a device to monitor *with* to a device to communicate *through*. This transformation intertwines the aforementioned user-device paradigms of interaction. While the lamp maintains its lighting functionality with the added potential of automation through its newly connected status, it also purposefully enables nonsymbolic communication between users on either side. Within this duality, I am interested in investigating opportunities for designing ambiguity [1,4], emergent patterns of obfuscation and asymmetries in agency.

Leaky Objects

The primary insight from this autobiographical design probe is the prevalence of meaning making embedded within the implicit information of if, when and how others interact with shared objects, artifacts and devices that are not intended to be explicit communication tools. During the design process of how I can communicate with objects about my partner to the experience of how I can communicate through a lamp with my partner, I reflected upon the multitude of both technological and non-technological things, from coffee cups to thermostats, that are already leaking implicit information and inadvertently enabling expressive communication and ambiguous speculation. An unused coffee cup might signify an intentional decrease in caffeine for the regular consumer, prompting speculation as to the motive behind the assumed change. Noticeable changes in room temperature could be perceived to suggestively express a modification in domestic finances or encourage sustainable practices. Thus, the lamp prototype is not novel in its appropriation, but what it exposes: leaky objects. Now knowing this phenomenon exists, what would designers have done differently if they knew implicit information was resulting in non-explicit communication? And how should designers approach connected objects, artifacts and devices moving forward in which this implicit information is increasing accessible?

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