LiveObjects: Leveraging Theatricality for an Expressive Internet of Things

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Figure 1: a) LightWire, an illuminated, spinning optic fiber that forms light bodies from social data, b) GorgeBox, an object that inflates based on the accumulation of data, c) LiveFans, two IoT controllable objects that actuate relational data.

DIS'16 Companion, June 04-08, 2016, Brisbane, QLD, Australia.
ACM 978-1-4503-4315-2/16/06.
http://dx.doi.org/10.1145/2908805.2908807

Abstract
LiveObjects approaches expressive object design from the lens of art theory utilizing theatricality, or the perception of an object having presence, to create a series of IoT data objects. This approach actuates materials and everyday objects to express social data and provokes new interactions between objects, viewers, and space. We showcase how such objects can form unique expressive personalities, expose relational data, and perturb environments to form information spaces.

Author Keywords
Ambient devices; data objects; data sculpture; IoT

ACM Classification Keywords
H.5.m [Information interfaces and presentation (e.g., HCI)]: Miscellaneous

Introduction and Background
As the Internet of Things (IoT) or the vision of ubiquitous connected everyday devices develops, we see opportunities to expand the design landscape of devices to go beyond neutral, atomic, functional, and obedient "things". Such devices process functional bits of information and mirror the data they receive in solely the space they occupy; interactions are often limited to quick punctuated glances with wearable devices, handhelds, and ambient screens.

Early work in ambient displays such as Jeremijenko's *Live Wire* [4] and Ishii's ambientRoom [3] showcase the value of expressing data in the cognitive background through ambient actuation. Data sculptures, or data-based physical artifacts, revealed that materializing data using the right forms and mappings can enhance a user's understanding of data and the social issues that underlie it [13]. Furthermore, as an alternative vision of "smart" is developing, a small subset of objects that co-inhabit our space are challenging the constrained objecthood of devices. As simple as naming devices, developing more intimate interactions have been shown to increase pleasure, social inclusion, and personal value in devices such as the Roomba vacuum [10]. Recent work such as AniThings [12] proposed animistic devices that have less imposing, yet unique personalities defined by their capabilities *and* limitations. Similarly, the Living Interfaces utilize zoomorphism and anthropomorphism to create socially-expressive robotics (a water-saving faucet[11], a needy toaster [1], and a kiss-operated lock [8]).

In contrast, *LiveObjects* approaches expressive object design from the lens of art theory and creates a set of IoT data objects that utilize theatricality, or the perception of an object having presence, to provoke new interactions where objects are active agents in a space. Theatricality refers to a term coined to critique Minimalist art objects in the 1960s (c.f. [7, 5, 2]). The three-dimensionality of these objects added a "theatricality", or an awareness of the object; such awareness would disrupt the "absorption" of the object with the viewer. For instance, a precarious one-ton assembly of metal plates [9] might elicit careful movement from audiences and exude a presence equivalent or greater than other bodies in that space. This "presence" carries large implications to proxemics, or the manner in which proximity with an object forms zones of interaction that play a large role in audience engagement [6].

Feature
Phrase Count
Sentiment (Polarity)[a]
Sentiment (Subjectivity)
Count
Velocity
Acceleration
Relative Count
Relative Velocity
Relative Acceleration

Table 1: Feature list from our Twitter scraper.

[a]Python NLTK Sentiment Analysis

LIVE OBJECTS

We created a series of IoT objects that explore theatricality through the use of material and space. All three objects track twitter data streams and express this social data through activation of materials and actuation. We describe our data tool and the design decisions, construction, and interactions with these objects.

Twitter as medium

We constrained the scope of our data source to Twitter for a variety of reasons: a) it is rich in relevant social and scientific data (e.g. @USGSted tweets up-to-date earthquake alerts), b) the data is diverse in subjectivity, and c) it has a highly accessible streaming API. As a brief overview, our tool is able to access tweets by person or entity (@), tags (#), and mentions. A select set of tweet data streams are logged into a database and the extracted features (Table 1) are exposed through a command-line interface. A Python API interface communicates to objects via Bluetooth; each object uses a Bluetooth Serial Port Module (JY-MCU).

LightWire

We draw inspiration from Natalie Jereminjenko's 1995 piece *LiveWire* (also known as *Dangling String*), an evocative data object consisting of a simple wire that vibrates as a function of network traffic data and operates in the cognitive background. For example, a user might be uploading a file, notice a significant delay, and discern from a rapidly oscillating wire in her periphery that network usage is high.

LightWire is a similar IoT object, yet it oscillates an optical fiber around an axis which creates light "bodies" from persistence-of-vision (Figure 2). At one end of the optical fiber (SGS2 5/64"), a DC motor is attached using a 3D printed motor arm; at the other end, the fiber is threaded through a support block and affixed to an enclosure containing an LED and battery, allowing the wire to free-spin.

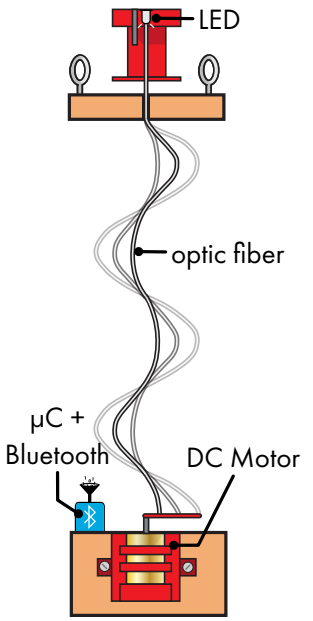

Figure 2: LightWire, an IoT object of configurable scale that oscillates an optic fiber back-and-forth.

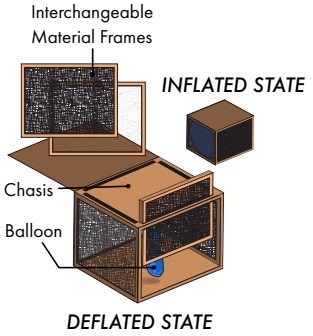

Figure 3: GorgeBox, a soft-actuated IoT object with interchangeable material frames.

By either varying motor speeed or altering the tension of the wire, we are able to create diverse waveforms.

This particular optic fiber consists of a solid plastic core with a thinner cladding (a material with a lower refractive index) which reflects light along its side. As the fiber bends from the oscillations, the amount of refracted light changes as a function of the bend radius. The analog factors of the wire's spin, such as its inertia and form, create imperfections that affect the versimilitude of the data it receives.

Although directly mapped to the data, from an observer's point-of-view the legibility of the data is ambiguous. For instance, mapping the earthquake data 1:1 to the dynamic range of wire oscillations will cause the wire to accurately display the data, however each data point will be subject to the last (e.g. a series of consequtive large earthquakes would appear very different from an earthquake over a silent period). In this way, the object takes on an inertial bias that high-fidelity digital displays lack. From a theatricality standpoint, the object achieves a notable presence from its sheer scale. In our construction we use a 3 meter fiber, which needs to attach itself to a rafter of a room, embedding itself and subject to the architectural space. The object inhabits that space, actively requiring a radius of space to operate and creates light bodies which require a "personal bubble" roughly equivalent to human agents. The visceral diverse forms it creates contributes to its liveliness, and while characterizable as an ambient device, it elicits peripheral attention.

GorgeBox

GorgeBox pits two materials against each other: the structural, seriousness of wood, and the playfulness of a rubber balloon. We construct a cuboid structure out of birch. Each face is formed from an interchangeable material frames. In our construction, we stretch different fabrics (an elastic nylon, a polyester mesh, and matte tulle) over these frames. Lastly, a rubber balloon and pneumatic control mechanism is inserted in the structure. The balloon is inflatable using an air pump where a digital control valve is used to maintain air pressure.

In our construction, we chose to implement a tweet "inbox" where we collected all mentions of a user over the course of the day. This could be in the form of direct messaging or side channel chatter. We mapped these values to output volumes of air which would continue to accumulate and inflate the balloon, "gorging" on this gossip, unless the user responded to these messages.

The GorgeBox makes use of the dynamic affordances of the balloon. As the balloon expands, it enters a different state of being; the tension of a balloon on the verge of explosion is a unique experience that captures attention. By constraining the balloon inside the frame, this expansion (and tension) is exacerbated and dramatized, eliciting an immediate user interaction. The balloon does pop if unattended, which offers a unique method of achieving "liveness" from the contrast of a exhausted object.

LiveFans

A pair of commodity fans with four-level (**HIGH, MED, LOW, OFF**) speed control were repurposed with a set of relays controlled by an Arduino microcontroller (Figure 4).

In the current space of IoT devices, control is often limited to the scope of a single object. As a pair, *LiveFans* explore how multi-actor systems can be leveraged to display relational data and collaboratively actuate an enviroment. The movement of air extends the scope of the data to the environment where this actuation can be felt by an audience in the vicinity of the fans.

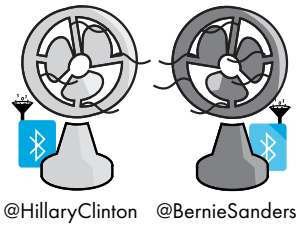

Figure 4: LiveFans, repurposed commodity fans turned into IoT device and sent oppositional data feeds.

As such, the data can form a dialectic; in the case of the fans, we control respective intensities using oppositional data. To showcase this, we harvested data from fifty of the top US politics Twitter accounts and searched for the relative acceleration of tweets mentioning the top two political candidates during an election season.Each fan is assigned a political affiliation and spins according to live tweet data. As such, a new subjectivity is introduced to these objects. This configuration forms a political "microclimate" that can be experienced by several users as an engaging, embodied interaction.

Conclusion

In this work, we demonstrate the design of objects with theatricality, or presence, by juxtaposing actuation, space, and material. Through this exploration we show how objects can exhibit a unique bias and personality, that the space of interaction can far exceed the bounds of the object to create information spaces, and that how materials can be used to dramatize interactions. At DIS, we invite attendees to experience how these theatrical IoT objects can engage audiences with data.

Acknowledgements

We thank Connor Freeman, Emily Chou, and Neil Kumar for their aid with fabricating live objects. This research was supported by NSF Grant No. IIS-1451465.

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