Systematic Review of Ambient Display Modalities, Physical Forms and Interactivity

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Introduction

What is an Ambient Display?

Ambient Displays are designed as everyday, peripheral information sources that visualise useful data in a way that can be attended to when possible.

Introduction

Research Overview

Longitudinal overview of the various forms of Ambient Displays over a twenty-year period

A comprehensive timeline of past work in the field of Ambient Display

Establishing a sound basis for further reviews or studies related to this technology.

The Field of Ambient Display

Historical Context

- Technology first recorded in the academic literature in the mid-1990s
- Calm Technology. A desire less intrusive displays in a noisy world of dynamic and ubiquitous information
- The field of Ambient Display forming in response to Calm Technology.

The Field of Ambient Display

Historical Context

- Some existing narrative reviews have surveyed restricted portions of the existing literature
- These previous reviews do attempt to cover the majority of historical examples of Ambient Display
- This study takes a longitudinal approach in systematically reviewing the first two decades of the technology's development

1. Provide a comprehensive timeline of historical studies in the field
2. Offer a sound basis for detailed meta-analysis of the technology
3. Act as an introduction to the field's progression across the design, development and evaluation of the technology

Systematic Review

Methodology

- Disparate nomenclature increased the difficulty in selecting appropriate search terms. Various naming conventions found to describe the base technology of Ambient Display
- Ambient Display, Ambient Information System, and Peripheral Display as key terms for search. Due to their reoccurring use throughout the field
- Data gathered from *ACM Digital Library*, *IEEE Xplore*, *Scopus* and *Web of Science*. Covering years from 1996 and 2016.

Systematic Review

Search Results

15,693 documents

Literature Assessment

1. Papers checked to determine if they described Ambient Display Technology. Design, implementation or theory.
2. Technology assessed against two archetypical descriptors of Ambient Display
3. Determination of if the described technology conformed to ideals of Calm Technology
4. Literature covering digital signage, advertising displays and interactive systems such as computer gaming were excluded

410 unique documents

Systematic Review

Search Results

Relevant literature found to cover four different research areas

1. Design and development (n=254)
2. Development (n=115)
3. Evaluation (n=7)
4. Theory or classification (n=34)

Systematic Review

Search Results

Within these studies were 459 Ambient Displays that were classified according to three general attributes which were found to reoccur across these implementations.

Modality

- An Ambient Display's mode of output

Physical Form

- An Ambient Display's physical form

Interaction design

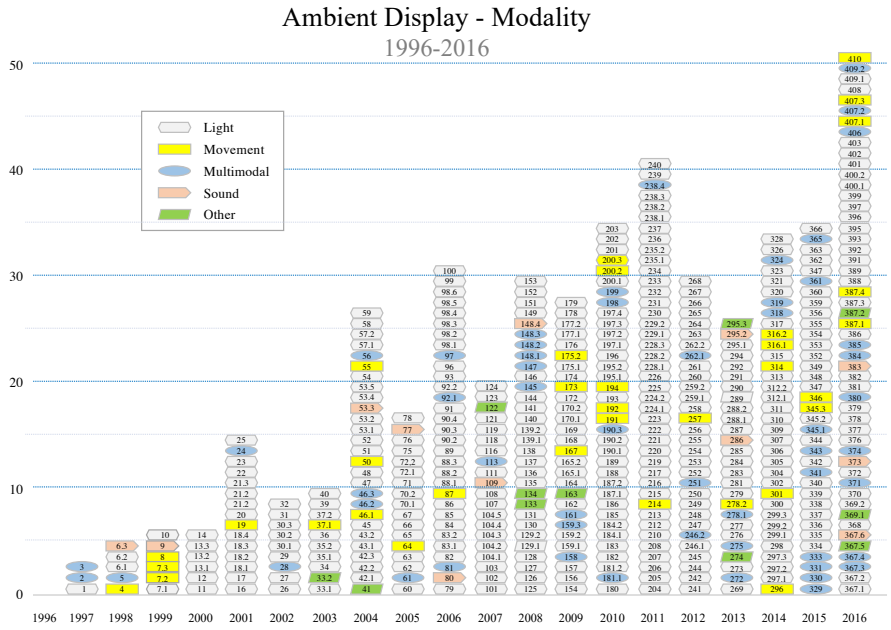
- Approach to interaction design

Modalities

Search Results

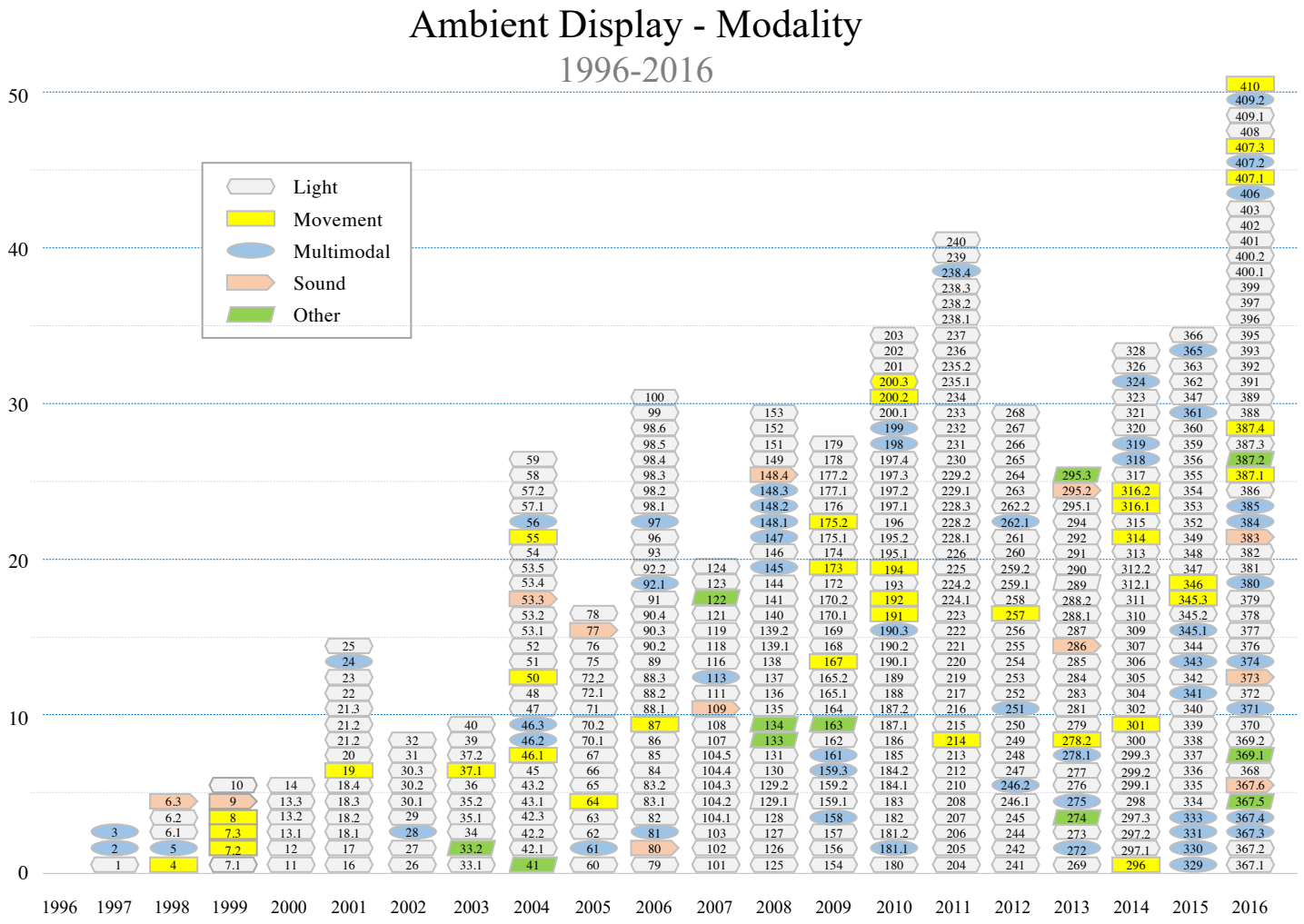
Output modalities across the review displays was found to be diverse covering:

- Light based implementations (n=348) – Physical lights, project images, traditional computer screens
- Multimodal implementations (n=54)
- Object movement (n=32)
- Sound (n=12)
- Vibration (n=9)
- Olfaction (n=2)
- Temperature (n=2)



Modalities

Search Results

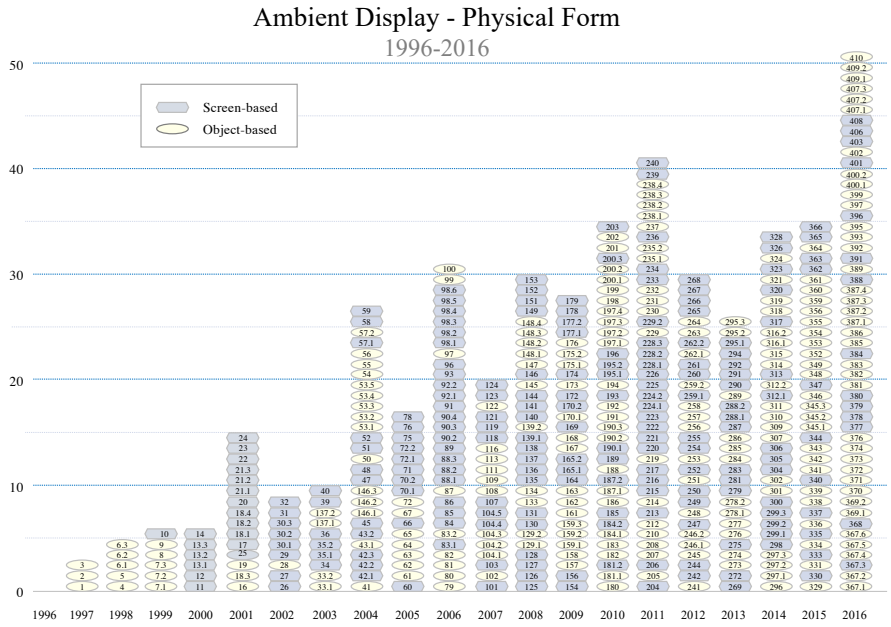


Physical Form

Search Results

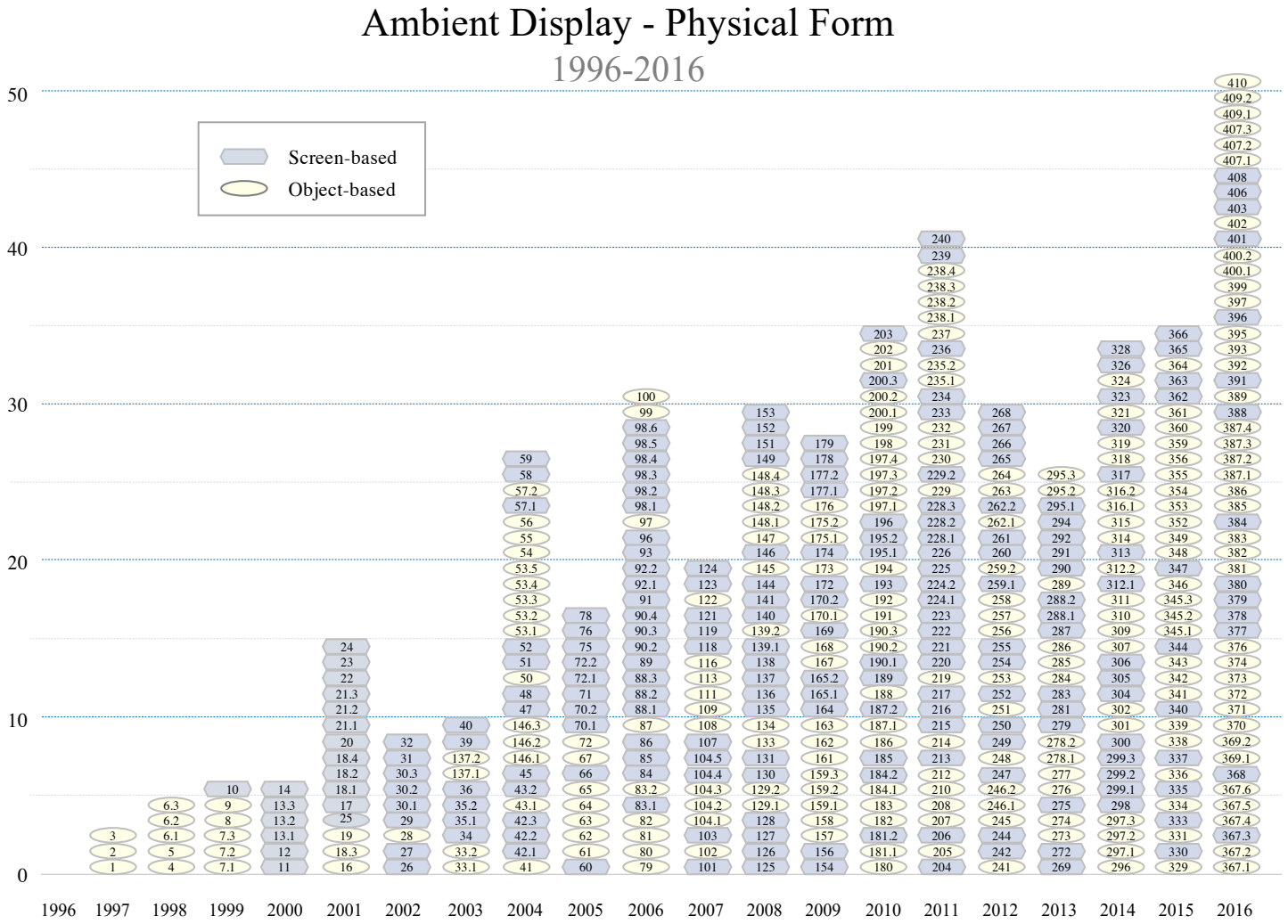
Two diverging approaching to display physicality found across implementations:

- Screen based displays (n=49% - n=224/459). Utilizing of the shelf display hardware such as computer monitors, televisions and digital projectors.
- Tangible display objects (n=51% - n=235/459)



Physical Form

Search Results



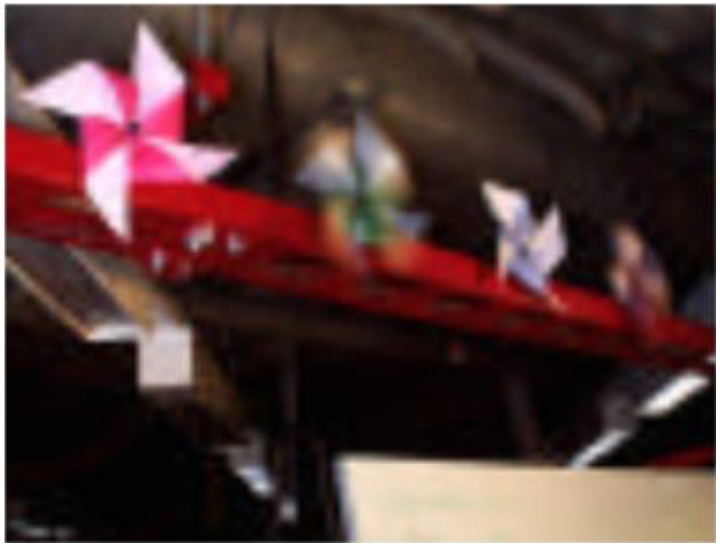
Physical Form

Search Results

Tangible Displays | Screen-based displays

Tangible or sculptural displays. Commonly make use of custom hardware for display output in the form of light or object movement. Typically limited in volume of visualized data.

The Information Percolator
Source (Heiner, Hudson & Tanaka, 1999)



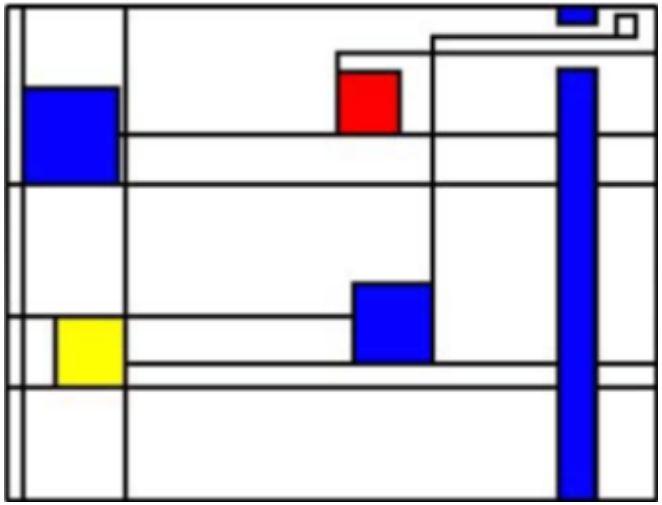
Pinwheels Ambient Fixture
Source (Dahley, Wisneski & Ishii, 1998)

Physical Form

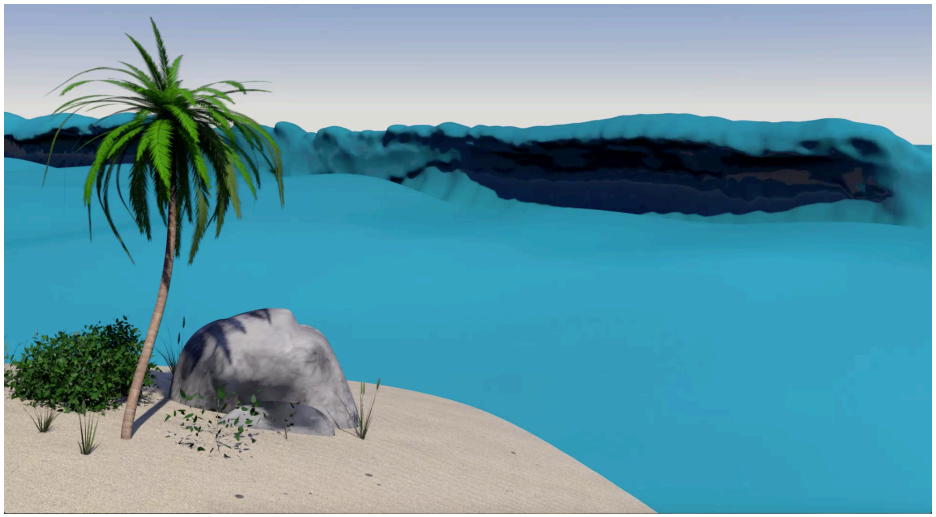
Search Results

Tangible Displays | Screen-based displays

Displays that make use of off the shelf display hardware. Focus tends to be in mapping layers of information into art-like compositions, typically in the form of pictures or posters



Informative Art
Source (Skog, Ljungblad & Holmquist, 2003)



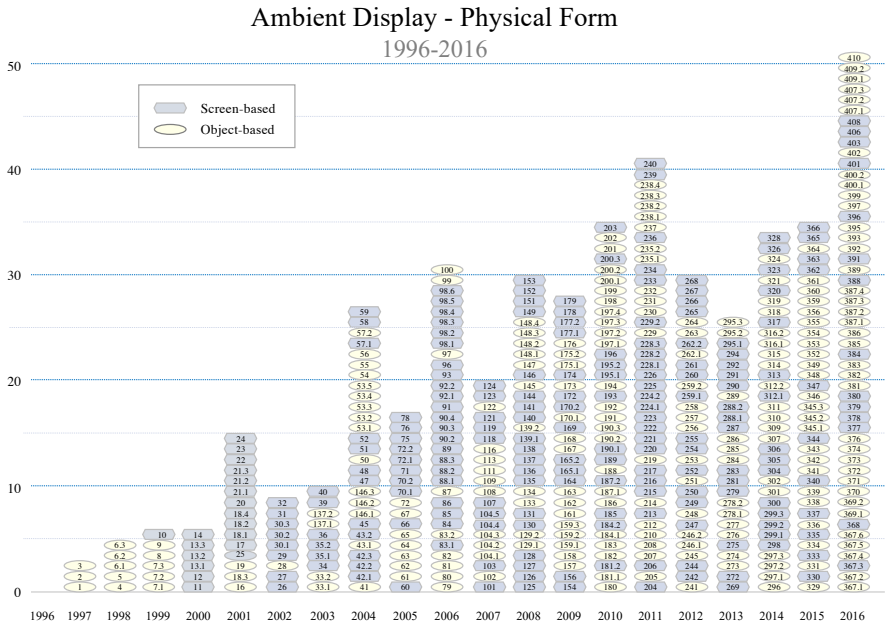
WaveWatch

Interaction Design

Search Results

Ambient Displays are typically designed to function with no direct input from the user. However, some systems while predominantly ambient, also support a low level of direct interaction :

- Fully ambient systems (58% - n=266/459). Ambient displays with no option for direct input
- Semi-ambient systems (42% - n=193/459). Systems which aim to remain peripheral but possess some incidental interactive capabilities



Conclusions

This longitudinal review of the field of Ambient Display highlights the great diversity in display modality, visualization approaches, form and levels of interaction

Existing displays found to diverge across three design attributes – modality, physical form and interaction design

Statistics gathered for each of these design attributes to allow longitudinal description of the technology

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Thank You

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