



IRIS

Intelligent Retail Information & Communication Systems

SETTING THE SCENE

Digital signage (DS) is commonly used in environments where people make decisions, search for information or require assistance. This makes it an important communication interface to display information at relevant moments and locations.

The digital screens that deliver DS combine high visibility, multimedia content and the ability to update messages in real time. Yet most screens still follow a one-size-fits-all broadcast model: every passer-by sees the same content, regardless of their needs, interests, goals or situation.

Advances in sensing and visual recognition technologies make it possible to move beyond this static model and develop adaptive DS systems that adjust their content in real time.

Such adaptation has the potential to make DS communication more relevant and engaging, but it also raises important questions about consumer acceptance, privacy and ethics.

FRAMING THE RESEARCH OBJECTIVE

In the IRIS project, we explored how digital screens can become more relevant without becoming intrusive, more understandable and effective, while at the same time safeguarding privacy, autonomy and social comfort.

To do so, we leveraged physiological tracking (such as gaze analysis and pupil dilation), neuroscientific insights and advanced image processing. The goal was to create and demonstrate a digital screen that adapts to consumers' attention, engagement and cognitive states in real time, while ensuring compliance with privacy regulations such as the GDPR and AI Act.

THREE MAIN OUTCOMES

The project delivered a real-life demonstrator showcasing the potential of personalized, context-aware digital communication in public and semi-public spaces, while also demonstrating its commercial viability. We validated the adaptive digital signage in both a university setting and the retail sector.

Our aim was to demonstrate that implicit neuroscientific insights can help increase audience engagement and communication effectiveness. Particular emphasis was placed on using these insights in a privacy-preserving way. The digital display was designed to adapt to how people respond in real time, reacting instantaneously without storing personal or private data.

This goal was achieved through several partial milestones and results, namely:

- We developed and validated a framework to capture visual consent for opting-in on context-aware DS messages (i.e., with thumbs-up).
- We developed a pipeline of novel methods for eye segmentation, gaze estimation, and pupil tracking that work on color images and at larger distances (more than 2 m).
- We drew up and validated a research workflow (i.e., a concrete list of steps to be taken and checklist of caveats) for conducting quantitative camera-based neuromarketing research in realistic contexts, as well as validated algorithms that predict behavior based on neuroscientific KPIs of attention and engagement, as measured via the cameras.
- We integrated gaze, explicit mood selection and contextual signals as inputs into a single content logic managed in Digitopia's CMS (Centoview/Xperify), where content managers configure scenarios, rules, and AI prompt profiles without developer intervention, turning hardcoded research prototypes into a manageable workflow.

- In terms of technical performance, our solution aimed to reach or surpass the current state of the art. For eye segmentation, our method achieved 98% accuracy on a benchmark dataset. For pupil tracking, we aimed to go beyond the usual tracking distance of around 1 to 1.5 m and achieved accurate tracking at distances of 2 to 3 m using visible-light RGB cameras. For gaze estimation, we achieved an angular error of 3.12 degrees in a real-life demonstrator environment, when testing at distances of 2 to 5 m.

The results of the IRIS project are promising. However, they do not yet constitute a sufficiently mature and well-defined product package. Further research, technical integration, scaling, robustness testing, privacy and regulatory assessment are needed before the exact components and business cases can be defined.

imec • Kapeldreef 75 • 3001 Leuven • Belgium • www.imec-int.com