Internet of Me: Experiential Exploration of Personal Digital Information Consumption with an AR Tool

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Abstract. The convergence of cyber-physical systems, expansive internet growth, and intensified human-device interactions have led to exponential data consumption, resulting in information overload within society. This research addresses this information overload and its impact on digital wellbeing through development of an augmented reality (AR) tool, aiming to facilitate personalized data-driven introspection and enhance the utility of consumed information. By merging digital and physical realms, the tool facilitates tangible data exploration, transforming complex information into understandable interactions. It extracts and categorizes user browsing history data by domains, days, and time and leverages OpenAI's LLM GPT model to categorize the consumed digital content. Developed with Unity, the AR tool visualizes the data in layers in users' environments, promoting active personalized data sense-making. This research introduces an approach to data presentation that promotes information literacy and envisions an empowered society having a holistic, informed relationship with technology where users seamlessly interact with their digital presence.

Keywords: AR/VR/MR, Information Overload, Data Sense-making, Phygital Landscape, Experiential Data Exploration

1 Introduction

With the convergence of cyber-physical systems, the rapid expansion of the Internet, and increasingly tighter interactions between humans and their devices, the data we engage with every day is growing exponentially, leading to an ever-expanding digital footprint. Currently, 63.1% of the world's total population uses the internet, and this continues to increase at an annual rate of 4% (Statista, 2023). In a world heavily influenced by the digital realm where on average, individuals spend approximately 6 hours and 50 minutes online, the boundaries between our physical and digital lives are blurring, leading to the emergence of what is often referred to as 'Phygital' lives, Coined in 2007 by Chris Weil of the advertising agency Momentum Worldwide. The intangible impact of the digital layer of our lives is often overlooked, while our behavior, habits, and personalities are now shaped by both these realities. By 2025, it is projected that each person will experience nearly 5000 online data interactions per day, representing a 300% increase in just 5 years (Reinsel, Gantz, & Rydning, 2017). Our digital footprint is not only linked to our activities on social media but also our browsing patterns and other online interactions. We are constantly inundated with an overwhelming amount of information from various online sources. The continuous stream of data and the volume of content makes it challenging for individuals to make sense of the information and apply it effectively in their lives. We are collectively experiencing information overload, a phenomenon also termed as "data dread," "data overload," and "infoxication". This information overload contributes to daily stress, our ability to comprehend and information we consume and significantly impacts our cognitive processes, affecting our mental health (European Parliament, Directorate-General for Parliamentary Research Services, Quaglio, Millar, 2020). There are four pressure points when people and online systems interact that cause the overload: the attention economy –bombardment with new information in short spans; choice architectures – which decide and manipulate the choices we make for consumption; online algorithmic curation – which taps into our behavior to curate content that we can't control; and us being prone to misinformation. There is an asymmetric and imbalanced relationship between platforms and users. While they understand our behavior and choices, we don’t have access or understanding of it. We find ourselves grappling with a sense of loss of control over our digital identities. (Lewandowsky, Smillie, Garcia, Hertwig, Weatherall, Egidy, Robertson, O’Connor, Kozyreva, Lorenz-Spreen, Blaschke, & Leiser, 2020).

In response to these challenges, this research project leverages augmented reality as a medium to create a personal sense-making tool for data-driven introspection, analysis, and understanding of our digital content consumption. This tool aims to make the hidden layer of digital information tangible and seamlessly integrated into our everyday environment. By extracting, categorizing, and contextualizing information, it provides an immersive and exploratory understanding of our digital behaviors and footprint, shedding light on the relationship between our digital lives and our physical surroundings. To illustrate its potential, the developed tool examines my personal relationship with my physical space and the data I consumed over a week as a case study.

2 Digital Wellbeing and Personal Data Concerns

‘Our common agenda’ – the global digital compact by the UN has declared greater focus on working towards internet accessibility, inclusivity, literacy and privacy (United Nations, 2021). 1 in 4 People have made changes to their technology to gain a greater sense of digital wellness. (Google, 2019) As digital wellbeing gains traction, and we become more curious about the information we consume, we will increasingly examine our digital activities. We are understanding the need for a better relationship.

The imbalanced relationship between users and platforms often leads to prioritizing information quantity and temporal metrics. To address this, it's imperative to amplify the value of consumed information, giving precedence to its relevance, density, and overall utility, empowering users to govern their digital surroundings, promoting information literacy and cognitive sense-making. Better comprehension and understanding of the information we consume are vital, as the inability to apply it effectively leads to lost knowledge.

2.1 Experiential Learning and Augmented Reality

We are accustomed to processing information by our senses; and it is desirable for us to use the same approach to interact with our data and information. The project aims to create a novel experience that transforms data into a dimensional reality, extending beyond screens into the physical world. Experiential learning refers to the process of engaging with information and data through practical experiences, similar to how we perceive and interact with the world through our senses. This approach has been linked to improved memory retention, higher motivation levels, and increased cognitive engagement, making the sense-making process more meaningful and memorable. AR holds significant potential for data sense-making, offering unique advantages that enhance users' understanding and interaction with the consumed information.

Enhanced Understanding of Complex Data: By overlaying digital information onto the physical world, AR promotes a comprehensive understanding of the information (Billinghurst & Duenser, 2012). Immersive AR facilitates experiential learning by providing a sense of scale, depth and perspective. The tactile nature of AR environments can lead to a more profound psychological impact like increased cognitive engagement, making the sense-making process more meaningful and memorable for users.

Dynamic and Customizable Data Interaction: AR offers real-time data interaction with dynamic content. Users can customize data representations based on their preferences, needs, and objectives, empowering them with greater control over the process. This fosters a deeper connection with the information (Johnson, 2011).

Contextual Relevance through Physical-Digital Integration: AR seamlessly integrates digital information with the physical environment. By overlaying data onto real-world contexts, AR provides contextual relevance and bridges the gap between abstract data and the physical environment Enabling users to relate and draw meaningful insights, facilitating informed decision-making (Bimber & Raskar, 2005)

3 Methodology

The aim was to gather and synthesize consumed digital information, extract behavioral analytics, patterns and content, and make it accessible via an AR visualization app. The approach encompasses three core phases: Data Collection, Analysis, and Visualization. These elements collectively underpin the development of a demo app, which was spotlighted as a case study.

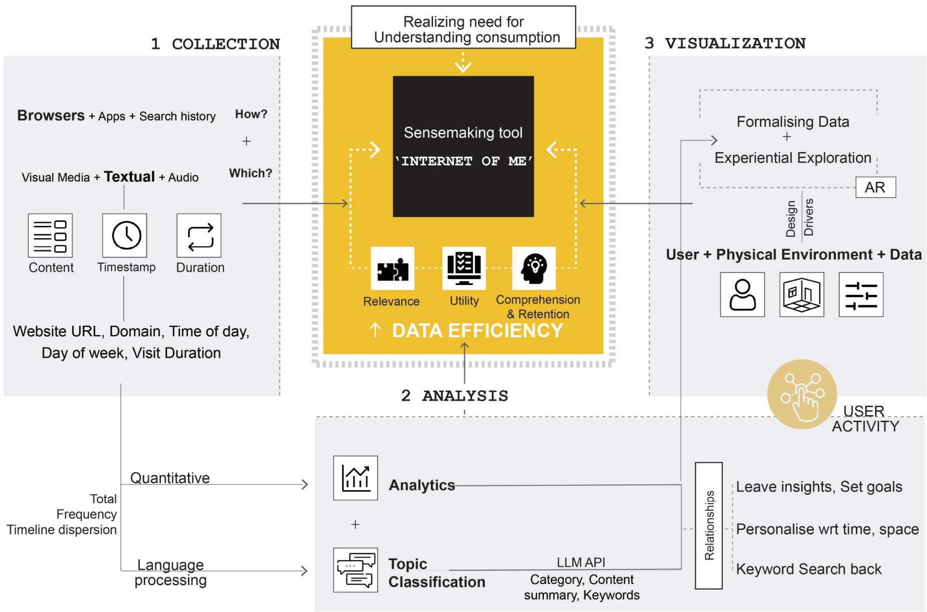

Figure 1. Research methodology diagram explaining flow of user information from browser history to visual, interactable output for sensemaking. Source: Author, 2023.

3.1 Data Collection

Assuming the tool to be in compliance with the guidelines set by 'The European Data Strategy, 2020 for privacy and accessibility terms, the scope was limited to collection of textual content from the browsing history of all devices of a user. 63% of the information searched is on Chrome as a browser. (Statista, 2023) So, the tool focuses on chrome browser-based extensions that track web activity with time to extract the time stamped history, and the duration of time spent on the websites of a week. For the scope of this research, existing two third party extensions were used for this data. The merged dataset had the information of the visited URLs, the domains, The visit time of the day, the visit day of the week, and duration. This data was preprocessed in python language for the removal of unresponsive websites and removal of consecutive duplicate websites within 30 seconds to get rid of auto-loaded sites.

3.2 Data Analysis

Content exploration and assimilation: Humans find it easier to comprehend information when it's arranged within familiar categories that relate to their daily experiences. The effectiveness of content exploration and assimilation are amplified when data is structured into meaningful and contextualized groupings (Parsons & Wand, 2008). Categorization isn't arbitrary, it adheres to predictable patterns. When individuals categorize entities or information, they draw upon their existing knowledge of those categories, enabling comprehension and prediction, utilizing their existing knowledge and mental frameworks to establish connections and derive insights. (Medin & Rips, 2005).

In this study, it was important to categorize all accessed websites into everyday associative groups. For the classification of digitally consumed information, appropriate categories were selected, encompassing Business & Finance, Entertainment, Health & Wellness, Learning & Education, Lifestyle & Culture, News & Events, Science & Technology, and Society & Community.

Natural Language Processing (NLP) text classifiers are machine learning models which involve analyzing textual data and predicting its category. The typical process of creating a classifier includes data collection, preprocessing, feature extraction, classifier training, model evaluation, and making predictions. This predicts categories for new, unseen text content based on probability scores. The success of an NLP classifier depends on the training data size, quality, feature extraction techniques, and choice of machine learning algorithm. Diversity and representativeness of data in each category during training also impact the classifier's effectiveness. While a custom NLP classifier was ideal, limited resources hindered creation of a comprehensive labeled dataset for this project. A dataset of content labelled with these categories could not be accessed or found. Instead, an AI Natural Language processing model provided a more practical alternative. OpenAI's LLM GPT model of davinci003's API was utilized for this purpose, categorizing content, along with short 2-line summaries and keywords from visited URLs through a determined prompt.

The collected and categorized data was analysed based on the aggregate websites, occurrence frequency of websites, and unique count values of websites of all six subheads, including URLs, domains, visit time of the day, visit day of the week, and duration. This processed data was then subjected to personal trend analytics, following a three-tiered hierarchical approach to derive insights -

Overview insights - Overarching insights of the entire activity dataset and general trends and patterns with respect to aggregate and count of URLs, day of the week and time of the day.

Categorical comparison - comparison of data across all 8 categories with basis on count, and duration, day of week and time of day assessment.

Category specific insights- Category specific insights from each category to highlight trends and patterns on basis of count, and duration, Day of week and time of day assessment.

3.3 Visualisation

Interactive relationship between the user, their data, and their physical environment is established to ensure seamless coexistence of digital and physical layers while creating a clear, understandable exploratory visualization experience (Figure 2). This research raises awareness about the quantity of consumed information along with enabling sensemaking for users. The developed tool manifests data into tangible-metaphysical forms. As users engage with the tool, each subsequent stage unveils additional focused layers, simplifying and augmenting their understanding. The initial phase showcases the total volume of information consumption in a period of time, allowing users to select specific content through time and date, relate it to their behavioral patterns to make informed decisions about its importance. Additionally, users can leave insight notes for future reference, enhancing the overall sensemaking process. The following aspects have been emphasized in effectively shaping the tool:

User Control and Customization: Recognizing that individuals perceive information differently, and that data comprehension varies due to user cognitive understanding, providing users with control over the typology and style of visualization display is essential. The framework facilitates user control over the medium and degree of information, visual style and colors, and the hierarchy of output visuals, offering flexibility to view information.

Active Engagement: To create a dynamic tool, features like search back, leaving insights, quantitative data goal-setting and comparison of patterns over time are included. This enables users to perceive measurable outcomes and motivates them.

Utilizing Physical Environment Features: The application extracts feature from the physical environment to inform the digital output. Through the camera, the app senses the space, making all horizontal surfaces at ergonomically reachable places interactive, while those on the ground with an offset of a foot are identified as walkable space. Additionally, computer vision technology enables real-time classification of objects within eight predefined categories, allowing spaces to be tagged accordingly. For instance, if a space predominantly contains objects related to entertainment, it is classified as an entertainment space, influencing the initial visualization sequence and enhancing user engagement. For the scope of this project, the assumption is made that the framework for real-time classification of space is already established, and manual classification is implemented due to constraints. Light levels are also considered, as the camera senses the amount of light through the brightness of captures. The visual color scheme can respond accordingly, making visuals brighter and more illuminant in dark spaces for improved visibility. In summary, the visualization component of this research enables an interactive and engaging user experience, providing control, customization, and insights derived from the physical environment to enhance the overall sensemaking process.

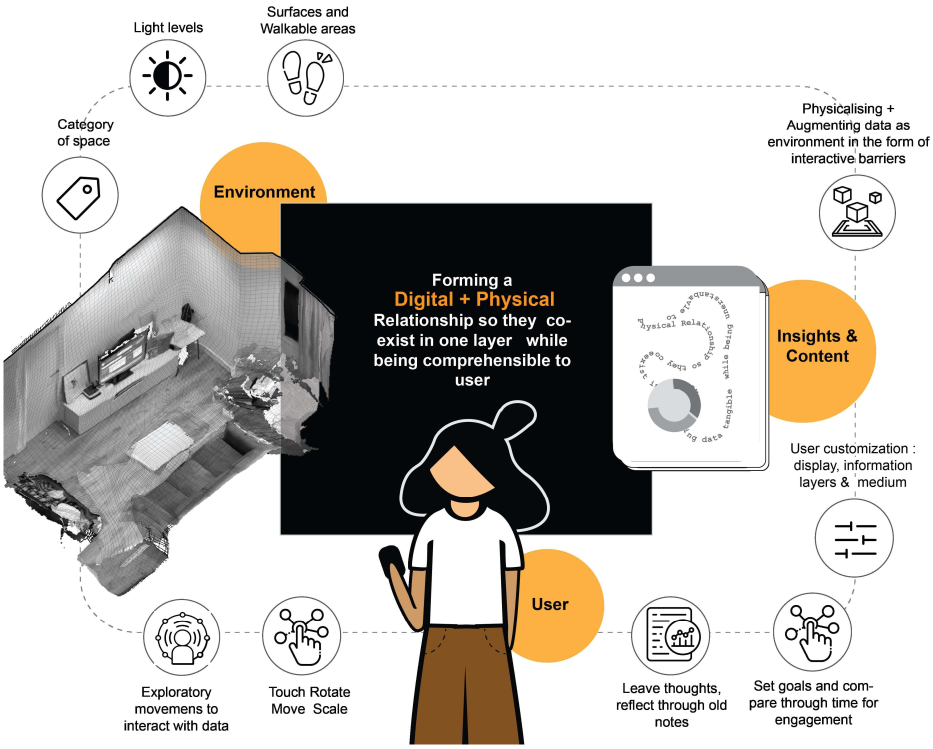

Figure 2. User, physical environment and data relationship. Source: Author, 2023.

4 Application Demo Development

The purpose of the demo tool is to showcase the potential of the research through an AR app named "Internet of me" that extracts and visualized my personal data.

Data Collection Phase: Chrome-based extensions were utilized to track all my digital activity, and data was extracted of a week (4th to 10th June 2023) across all my devices.

Data Analysis: The combined cleaned dataset contained a total of 108 unique websites, with cumulative time spent of over 15 hours. Classification of the dataset was accomplished using the predefined categories, and three-layer statistics were extracted using Python with the ‘pandas’ library.

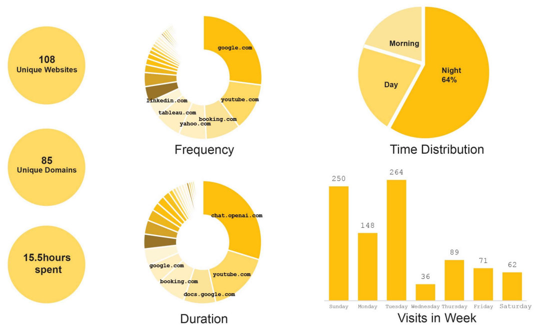

Figure 3. Overview insights statistics showing entire activity of 4th to 10th with general trends to make first information layer of visualization tool. Source: Author, 2023.

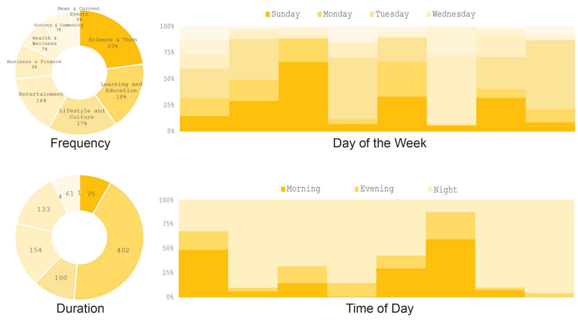

Figure 4. Categorical comparison across all 8 categories from 4th to 10th to form design parameters for category visuals and second information layer of visualization tool. Source: Author, 2023.

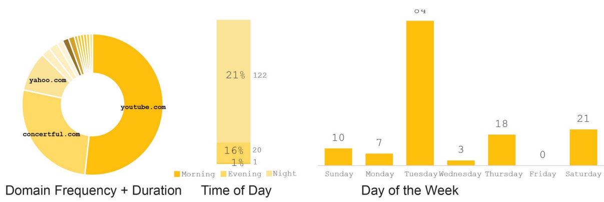

Figure 5. Statistics from each category to form third information layer that can be arranged in - Domain frequency, time of day and Day of the week. Source: Author, 2023.

Data Visualization: The application was developed using Unity3D and Vuforia was used to create a "Vuforia area target" through lidar scanning, forming the physical marker. Subsequent stages of development involved integrating the forms created in Grasshopper for Rhino, and were visualized as extensions of the environment, resembling object barriers connected to vertical and horizontal existing surfaces of the physical space. Each form's size and shape parameters were based on the dataset of the week. My scanned living room as a marker was loaded, and with an assumed possibility of classifying typology of the space using computer vision segmentation from the set predefined categories, The space was classified as ‘Entertainment’ as the number of items classified belonged mostly to entertainment class. It therefore became the default stage for display of second and third-layer information reveal later on.

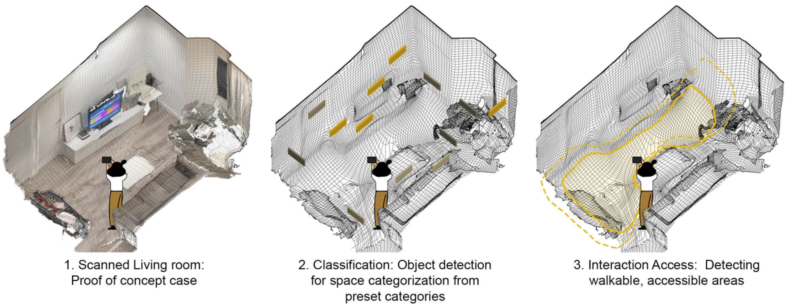

Figure 6. Area marker, extraction of physical features. Source: Author, 2023.

1. Functioning as an awareness stage for personal total volume of consumption, all textual consumption is mapped as unseen additional surfaces of the space, and text moves on it. The first information layer of overarching insights based on total quantities is revealed here as well.
2. The next phase reveals the data in categorized segregated spaces. The locations are based on area classifications, while anchored to the physical space. For example, entertainment data is mapped near the television. The size is dependent on the aggregate quantities of the specific categories, and the color palate is assigned on the basis of light levels. Next to each category the second layer of information is displayed as interactable buttons for navigation.

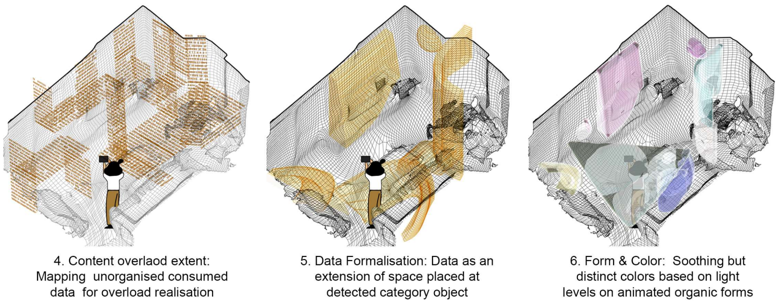

Figure 7. Stages of first two layers of information. Source: Author, 2023.

3. Each category can be uncovered by clicking these buttons to show the third layer of information of category specific consumption with summaries and keywords, and options to visualize them with respect to the day of week, time of day or domains.

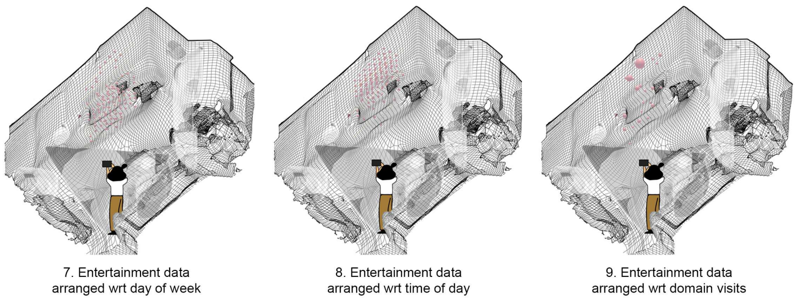

Figure 8. Third level information and arrangement options. Source: Author, 2023.

4. Modes like goal setting for comparisons, aspirations and leaving notes in specific related spaces keeps the user engaged over multiple usages of the tool. A consistent UI helps in maintaining the flow between stages.

Figure 9. Screenshots of UI and different phases. Source: Author, 2023.

5 Discussion

The project introduces a tool that envisions a harmonious coexistence between users and their digital landscape, harnessing emerging technologies like language processing and augmented reality to revolutionize data visualization for practical applications. This framework seamlessly integrates data into our physical reality, aiming to facilitate personalized self-reflection by translating intricate digital behavioural data into familiar physical contexts, transforming data into a dimensional experience.

In today's data-driven world, an increasing amount of information is consumed as well as collected about individuals and their surroundings. Most people do not actively engage with their data or fully comprehend its implications due to its obscure formats. The developed tool seeks to bridge this gap by allowing individuals to understand and relate to their consumption to make informed decisions.

Figure 10. Tool demo in a space classified as ‘Educational’. Source: Author, 2023

The research project fosters experiential spatial exploration and interactive visualization, presenting an approach to define a Phygital relationship. It empowers users to gain insights into their digital consumption patterns, enabling them to curate their digital presence and make meaningful connections with the information they interact with. This research lays the groundwork for an approach to personal data presentation and interaction and holds great potential to be better integrated with the physical world through head-mounted devices that allow hand gestures, as well as enhanced data analysis and processing through collaborations with experts. Through collaboration, it will become easier to categorize and segment the physical world through a camera, making the proposed workflow for relationship between data forms and the environment feasible.

In conclusion, this research significantly contributes to the ongoing efforts to make data meaningful and relevant to individuals' lives. By envisioning a future where users can seamlessly interact with their digital selves, the tool fosters a healthier and more informed relationship with technology. Through innovative visualization and a user-centric approach, the tool serves as a stepping stone towards a more connected and empowered digital experience, transforming the way we engage with and perceive our digital presence.

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