Intelligent Hypertext for Video Selection: A Design Approach

Susanne Purucker*
Hof University
Institute of Information Systems
Hof, Germany
susanne.purucker@iisys.de

Claus Atzenbeck
Hof University
Institute of Information Systems
Hof, Germany
claus.atzenbeck@iisys.de

Daniel Roßner
Hof University
Institute of Information Systems
Hof, Germany
daniel.rossner@iisys.de

ABSTRACT

In this paper, we describe our project *DemoMedia*, a software demonstrator that combines hypertext and recommender functionality in the context of video acquisition or use. *DemoMedia* fills the gap that exists in today's video platforms which include recommender functionalities, but only trivial support for users to structure information. Thus, users are forced to write down notes from or about videos (needed for various reasons) on additional media, such as paper. This opens a media gap between video platform and note-taking or communication to others.

DemoMedia becomes a note taking and communication tool for the user, as it offers a knowledge space on which users can freely arrange and associate information. Furthermore, its intelligent parsers compute relations that are implicitly expressed and queries knowledge bases for relevant information or related videos. Those get positioned on the space in a semantically meaningful way. *DemoMedia* and the underlying component-based open hypermedia system *Mother* combine both the machine's capability of extracting knowledge from huge amounts of data and the human capability of sensemaking, intuition, and creativity.

CCS CONCEPTS

• **Human-centered computing** → **User studies; Hypertext / hypermedia; Graphical user interfaces.**

KEYWORDS

hypertext; hypermedia; spatial hypertext; media consumption; television; entertainment; education; decision making; knowledge; communication; *DemoMedia*; *Mother*

ACM Reference Format:

Susanne Purucker, Claus Atzenbeck, and Daniel Roßner. 2019. Intelligent Hypertext for Video Selection: A Design Approach. In *2nd International Workshop on Human Factors in Hypertext (HUMAN'19)*, September 17, 2019, Hof, Germany. ACM, New York, NY, USA, 8 pages. <https://doi.org/10.1145/3345509.3349279>

*Corresponding author

Permission to make digital or hard copies of part or all of this work for personal or classroom use is granted without fee provided that copies are not made or distributed for profit or commercial advantage and that copies bear this notice and the full citation on the first page. Copyrights for third-party components of this work must be honored. For all other uses, contact the owner/author(s).
HUMAN'19, September 17, 2019, Hof, Germany
© 2019 Copyright held by the owner/author(s).
ACM ISBN 978-1-4503-6899-5/19/09.
<https://doi.org/10.1145/3345509.3349279>

1 INTRODUCTION

Hypertext as a medium enables people to create connections between information. It breaks up the stringed information flow enforced by other structure types, such as linear structures (e.g., how we mostly read books) or hierarchical structures (e.g., as the file system browser forces us to organize files). The use of links in hypertext opens a higher level of freedom and enables users to express their associations freely. This supports the way we think, as it enables the creation of appropriate tools for expressing our thoughts. Once explicitly expressed in a computing environment, it becomes easy to communicate them to other people in various ways, for example, in front of a single shared screen during a face to face meeting or over computer networks. It is no surprise that Conklin recognized in his 1987 paper hypertext as a “computer-based medium for thinking and communication” [12].

We consider hypertext as a tool for augmenting human capabilities in thinking or organizing information, as described by Douglas Engelbart. He defines augmentation as follows: “By ‘augmenting human intellect’ we mean increasing the capability of a man to approach a complex problem situation, to gain comprehension to suit his particular needs, and to derive solutions to problems.” [13]

Today, organizing or browsing information are widely spread tasks in various fields, including education and research (e.g., writing or organizing excerpts from multiple articles aiming at creating new texts), household (e.g., classifying various cooking recipes according to the meal type), or entertainment (e.g., creating lists of movies or browsing film categories on broadcasters' websites). However, many organizational tasks are still based on limiting structuring capabilities (e.g., hierarchies or lists), not offering hypertextual linking.

Additionally, the increasing importance of AI in our daily lives supports a culture of using computers without asking for augmenting human intellect. We assume that the machine serves as an assistant for *automating* tasks, not expecting it to provide means for expressing our own thoughts. Recommender systems, such as the ones used by online shops or movie or music platforms, inform us, for example, about goods or media of interest to us individually. This is based on the analytics of our and other's preferences or behaviors. However, structuring information on such systems is mainly limited to *lists* (e.g., shopping lists or media play-lists). In many cases, not even hierarchical structuring is possible, as we know it from many computer applications.

On the one hand, the AI part, which is a huge topic of its own, becomes more and more important and omnipresent. On the other hand, support for structuring tools for the human user decreases. It seems that an increasing level of automation tasks decreases

Figure 1: Reasons for consuming video content

the level of support for augmenting human intellect. We argue that this is not a necessity and, furthermore, that a combination of intelligent machines and tools for capturing/augmenting human thinking creates synergies and added values.

In this paper, we discuss our research in the domain of entertainment, in particular related to the search for or the use of video content. This work is based on a cooperation with Loewe Technologies, a German manufacturer of high-end television devices. In the following discussion, we put a *strong focus on the analysis of real-world examples* by the means of usage scenarios. This helps us to better design an appropriate system and understand its added value to the users.

The remainder of the paper is as follows: In Sect. 2 we analyze the status quo in selecting or making use of video content based on four usage scenarios. Section 3 discusses our solution to the identifies problems. Our demonstrator, *DemoMedia*, is described in Sect. 4. Finally, we conclude this paper in Sect. 5, which also refers to future work.

2 ANALYSIS AND USAGE SCENARIOS

2.1 A Heterogeneous Initial Situation

There is no concept of “the one” universal film or multimedia consumer. The target group in the entertainment sector extends across all age groups and social milieus. Also, the reasons why people watch certain movies or channels or the devices they use are similarly diverse. The same is true for the question whether movies are watched individually or in groups.

The purposes for the consumption of videos can be divided into two main areas, namely passive and active. For passive consumption, people want to be entertained or pass the time while watching movies; in active consumption, people aim for knowledge acquisition or want to find creative inspiration. Also mixed forms are possible [4, 17]. Figure 1 provides an overview of possible reasons for consuming video content, organized in the mentioned two areas.

While the traditional format of TV broadcasts shows the longest usage time per day in Germany [31], the daily usage time of *over*

the top (OTT) alternatives increases steadily, in particular among younger users [23]. OTT includes, e.g., live streaming, catch-up TV (media libraries), video on demand (VOD), or user-generated content.

The number of viewers in Germany older than 14 years who do not want (any longer) to stick to a fixed program schedule offered by TV stations or static transmission times is steadily increasing. A total of 38 % make already use of TV channels’ media libraries at least once a month (i.e., video on demand) [21]. Other streaming services (e.g., Netflix or Amazon Prime Video) show a monthly usage of 40 % compared to media libraries [21].

A similar age distribution between younger and older users can be observed with respect to the device used for watching movies in the German speaking population aged 14 and above. Almost $\frac{1}{3}$ of the 14 to 30 year olds use their personal computers for watching short video clips, $\frac{1}{4}$ a smartphone, and only $\frac{1}{4}$ a television. For movies, however, only 9 % of young people use their smartphones [14].

There is also an increasing number of TVs with smart functions. By 2017, 70 % of newly sold TVs were already smart TVs [32]. TVs become media centers connected to a huge network of media providers.

2.2 Four Usage Scenarios

We define four specific usage scenarios in order to reduce the large number of variations and enormous diversity described above. *Our goal is to identify a few archetypal users for different scenarios*, understand their concrete needs, skills, goals, objectives, behavioral patterns, preferences, and expectations. That is, we identify a small number of tangible identities and their facets for specific usage scenarios [20].

Figure 2 depicts the iterative process of reaching a decision about which movie or video to select. This includes both rational and emotional considerations. Based on that, we recorded subjects’ intentions, expectations, and emotions while they were solving tasks related to selecting, communicating, or watching movies or making use of their contents. Our evaluation focuses in particular on interactions needed for the selection of the content actions thereafter. This includes the following questions [cf. 18]:

- What are the expectations?
- What does a person want to achieve?
- What are system requirements?
- How does a person perform the interaction?
- How does a person feel?

These questions put us into the situation of a potential user and let us develop an understanding for certain behavior, including a better understanding of his/her actions, needs, and perceptions, or tasks to be achieved. These user insights are obtained by the qualitative creation of *personas*.

We consider individual *user journeys* of the following four persons or groups to analyze their needs or their unsatisfying experiences, so-called *pain points*:

- (1) *Jane* (84), pensioner. Conservative, traditional milieus, farmer, interested in plants. Watches TV broadcasts. Scenario: television series

Figure 2: Decision making for selecting a movie or video, adapted from [11]

- (2) Amy (26) and Ben (5), mother works as welder in the industry, son attends kindergarten, family. Co-viewing OTT. Scenario: entertainment for Ben before lunch
- (3) Amy (26), Miriam (23), Sebastian (42), and Florian (33), friends. Co-viewing, channel irrelevant. Scenario: joint movie evening
- (4) Florian (33), Sebastian (42), Andreas (32), interest group. Co-viewing, different media OTT, text messages. Scenario: jointly planning and constructing an earth sieve

Case 1 is based on a radio report [33], the others were created on the basis of observations of real users and subsequent interviews.

The different usage scenarios are not about the video content itself, but rather about how the content has been found. Therefore, the scenarios are split into three parts: (i) finding; (ii) watching; and (iii) finding and/or storing relevant information. In the following, we describe each of those in greater detail.

2.2.1 Finding. Case 1: Every week Jane watches the “Gardeners World”, a series about garden design. As a source of information, she exclusively uses the print medium television magazine and integrates the broadcasting times into her daily routine: every Thursday during tea time she enjoys the series.

Her approach to discover interesting content corresponds to the majority of offline TV users. 35 % of them get to the video content using a TV magazine, 28 % via TV ads, and 27 % become aware of them through recommendations (i.e., word of mouth) [3].

Case 2: For Amy, on the other hand, the time period for which she needs entertainment for her son is limited. After she has fetched Ben from the kindergarten, he may watch some TV in the kitchen while Amy prepares lunch. This keeps Ben busy during that time. Before Amy starts cooking, she and Ben jointly consider various media libraries and select a movie. Amy may have already received recommendations from other mothers or she and Ben pick a video based on advertisements within the media libraries or home screen recommendations.

Their behavior in becoming aware of new content through word of mouth (13 %), banner ads (24 %), or recommendations within the portals (21 %) is significantly lower than the most commonly chosen online methods in 2017 in Germany: 38 % of the people are

browsing blog posts, news and online articles to discover video content [3].

Case 3: An essential goal of the *four friends* regarding their movie evening is to agree on a film that corresponds to everyone’s interests, is new to them, and free of charge. The coordination process between the friends is usually lengthy and begins a few days in advance via smartphone messengers [11]. The search for the most appropriate movie is not limited to a specific channel; it includes live TV broadcasts, media libraries, or streaming platform providers.

Case 4: In this scenario, a *group of people works on a common task*. First, they query a Web search engine with different keywords. The interest group meets face to face to discuss possible solutions. The content retrieved is of various types, including text, sound, or videos. Searching the Web is the second most frequently used source of information in Germany (71 %). Only the personal way of asking users, friends, or acquaintances is chosen more often (80.3 %) [2].

To summarize, content is found differently by various user groups. For live broadcasting, TV magazines are the most frequently used sources, while on the Internet search engines are mostly used to find content.

The online user behavior can be subdivided into individual steps from the search engine result list to retrieving the desired video. We identified several pain points on the user journey in situations where the desired content cannot be searched instantly because the title or the required search terms were not specifically known to the user.

The actions taken by the user for searching a film online can be described as a linear process as indicated in Fig. 3: starting with opening the browser and entering a keyword, select a search result that leads the user to the website with the content, checking the content regarding its relevance, and finally watching the film. If the user does not like the content, he/she has to step backwards to previous actions. With every step back the satisfaction of the user decreases. In particular, the following pain points can be identified:

- (1) The quality of the result lists depends on the quality of keywords used. In none of the observed cases did the first search

Figure 3: UX of searching videos on contemporary online platforms

lead to the final video consumed. The keywords were adapted several times or have been changed completely. Thus, search can be considered as an iterative process.

- (2) After a user has found the desired video, he/she is still several clicks away from the actual content that may be used in a decision-making process.
- (3) The user reaches media libraries via search engines. Media libraries offer the user the following possibilities to access their contents: (i) browsing predefined categories; (ii) using a search field (in a similar way as search engines); and (iii) recommendation system based on the user's own preferences, the analysis of his/her behavior, other users have also seen or the content would like to be promoted by the platform provider. It is difficult to request recommendations based on multiple explicit properties, for example, a thriller that is suitable for children and was produced in the mountains.
- (4) If several users are involved, the described processes are completed by each individual and communicated or discussed multiple times during the coordination phase. In order to reach a joint agreement, a communication channel outside the film portal is required. This leads to the use of several distinct (i.e., unconnected) media.

2.2.2 Watching. We did not evaluate the actual content consumption time span, but rather the purpose or motivation behind.

Case 1: The garden design and the discussions about plants are *Jane's* main interests in the show. She wants to continue learning and find inspiration regarding plants for herself.

Case 2: *Amy's* goal is to select pedagogically valuable content for Ben. The video length should correspond to the time needed for cooking. Furthermore, she wants to avoid playing already watched videos multiple times.

Case 3: The aim of the *four friends* is joint entertainment, spending time together, creating common memories [17], or talking about other events that happened since their last meeting (while the movie is playing).

Case 4: The focus of the *interest group* is mostly on gaining information to solve their problem at hand.

The intentions for watching movies or videos differ in the four usage scenarios. As described in Sect. 2.1 and depicted in Fig. 1, we distinguish between passive (e.g., as with *Amy* and *Ben* in case 2) and active consumption (e.g., as with the *interest group* in case 4). Often, a mixed form of both occurs, for example, *Jane* (case 1) is

entertained by the series and is learning about new plants or types of care.

2.2.3 Storing Relevant Information. Users mostly want to find content that is relevant or of interest to them. Furthermore, users need to be aware of what they have been watching already, that is, they need to be able to identify new information. *In all observed cases, people experienced a gap in media, because watching videos or movies and taking notes are not connected.*

Case 1: *Jane* takes notes about plant names and care instructions on a sheet of paper for later use. She collects the individual pages on the sidebar. Clearly, the gap noticed between TV and paper is even defined by digital versus analog media, which cannot be connected as such.

Cases 2 & 3: *Amy/Ben*, as well as the *four friends*, want to avoid already seen content. In order to support this and to speed up the joint decision-making process, they take notes of movies they may want to pick in the future or that they jointly excluded for some reason.

Case 4: During the search process, the *interest group* sends newly found information as URIs via instant messengers to all participants. This also serves as a storage medium for URIs. Additionally, group members scribble ideas or discussion results on paper from which a final solution will be compiled at the end.

To summarize, currently searching includes a cognitive overhead on users, as they constantly have to “translate” their notes to new keywords or queries and vice versa. Due to the media gap, the video platform cannot support the user sufficiently.

The integration of various services (e.g., Amazon Movie, YouTube, broadcasters' media libraries) for a better user experience is against most providers' business goals. As service on-demand platforms aim at keeping the user exclusively on their platform as long as possible, it becomes difficult to imagine an open system that would feature integrated search, player capabilities, note-taking, and communication tools.

Current video platforms mostly offer simplistic structuring facilities, which exist commonly as playlists. Some providers also offer to add comments to individual clips. However, videos or information within those cannot be structured freely on the platform itself. This limits the user, who has to take notes on or communicate via other media.

In fact, the preferred way to store information in the use cases discussed above is to switch media from video to paper and pencil,

instant messengers, etc. In the following, we will propose an advanced way of combining search, consumption, and note-taking. We argue that this offers significant benefits for users.

3 A HYPERTEXT APPROACH FOR SELECTING AND USING VIDEOS

In the previous section we have introduced four user journeys in which we identified (i) the reasons for watching videos; (ii) how videos are found and selected; and (iii) why and how related note-taking or communication takes place. The most important discovery is that beside searching or selecting videos, there is a strong desire for note-taking or communication for various reasons. In most cases, video consumption includes some sort of decision-making process or communication. Neither live broadcasting nor current streaming platforms integrate sophisticated note-taking or communication support (except for sharing links to videos). Users are forced to accept the media gap between the search or consumption of videos and note-taking, structuring, or communicating to others.

This has an immediate relation to the users' thinking. As argued in the introduction, the human brain works by associations. The means for structuring on streaming platforms or media libraries, however, are simplistic and, thus, insufficient for the needs expressed in the scenarios.

The first challenge toward a solution for the raised question is to identify tools and systems that would support the augmentation of human intellect. As we have shown in the previous section, all scenarios included some knowledge work. For some this was even a major task, for example, in case 1, in which Jane took notes about gardening or in case 4, in which some friends organized information in order to solve a construction problem at hand.

Hypertext provides to structure content in a very flexible way. The most prominent structure type is *navigational hypertext* (cf. the Dexter Hypertext Reference Model [15]), which follows a node-link paradigm. Examples go back to the very early ideas [10] or systems (e.g., Xanadu [25] or NLS [13]) or early commercial-level applications (e.g., KMS [1], Hyperties [29], NoteCards [16], Intermedia [24], Guide [9], HyperCard [30]). Also the omnipresent WWW [8] is based on the idea of nodes and links.

However, nodes and links are not the only way to structure information. For example, nodes can be organized and put in relation on a space by their placement or common visual cues. This is called *spatial hypertext* [22]. Using this informal way of organizing is in particular appropriate for preliminary or emerging structures, as associations are implicitly created by interpreting the nodes on the space. This would fit most of the decision making processes described in Sect. 2. In particular, the note-taking ("scribbling preliminary ideas on paper") described in case 1 and case 4 could conveniently be done using a spatial hypertext system.

Figure 4 depicts the idea behind explicit (e.g., as in navigational hypertext) and implicit (e.g., as in spatial hypertext) associations: Whereas connections using links are explicit and do not depend on any interpretation, implicit associations must first be interpreted. Ambiguous or fuzzy interpretations are possible (and likely), depending on the person or algorithm interpreting the structure.

We propose solving the raised issues by a system that combines hypertext (in particular spatial hypertext) and recommender

Figure 4: Comparison of explicit and implicit associations between information units

functionalities. This is the core idea of our component-based open hypermedia system (CB-OHS) *Mother*. In previous publications, we have already discussed various facets of the overall system [cf 5–7].

Mother's main feature is a spatial hypertext client on which users can add nodes. In the context of selecting video content, nodes may include information, e.g., actors, directors, movie titles, or genres. Those are organized spatially by the user. Furthermore, *Mother* includes some knowledge bases that are used to suggest related information to the user. The knowledge base related to this project includes, for example, information about movies (described in greater detail in Sect. 4). In order to enable the system suggesting information relevant to the user-created structure, specialized parsers interpret the 2D space and identify associations [cf. 28]. As a result, user and machine reach a common "understanding" of associations expressed implicitly on the space. This understanding is used by the system to build more specific queries, as the visual structure is a fundamental part of them. Knowledge bases suggest relevant information to what the user has created on the space. The demonstrator *DemoMedia* is described in greater detail in Sect. 4. The visualization of suggested nodes is subject in our recent publication [27].

Our goal in this project was to support decision making or knowledge building for individuals or teams, as needed in situations described in the four scenarios (Sect. 2). *Mother's* spatial hypertext, its parsers, and the knowledge base can be considered as a note-taking application and recommender system simultaneously. While taking notes or organizing ideas on the space, the system places information related to videos, recommended videos or movies, or even the movies themselves on the space. They integrate with the existing user-added nodes in a semantically meaningful way.

How does this improve the overall UX or workflow for users? Firstly and most importantly, it removes the media gap that has opened because taking notes and searching/watching video content is not provided by a single platform or at least on integrating platforms. Furthermore, it supports communicating notes and their contexts to others, e.g., during face to face meetings or over a network.

Secondly, the user journey depicted in Fig. 3 (which often leads to frustration for the user due to jumping back and forth) gets simplified, as suggested in Fig. 5: Instead of frequently typing search queries or opening pages to preview from the list of results, the UX is basically reduced to interacting with the system generated recommendations.

Figure 5: UX when making use of recommendations

Inserting keywords only needs to happen in the very beginning or whenever a user wants to change the scope of what is represented on the current knowledge space. Furthermore, recommended movies or trailers can be previewed or played already on the space itself. Thus, the user takes notes, gets recommendations (which can become part of his/her notes by simply dragging them to an intended position), and can preview or watch videos presented already in-place.

This combination of hypertext and recommender system strongly supports the human, as it offers more than simply selecting recommended videos or information: users can build up knowledge or communicate information while they receive computer-generated information appropriate for the tasks at hand.

In the following section we will describe our demonstrator *DemoMedia*, a *Mother* client running on Android tablets, in greater detail.

4 THE DEMOMEDIA SOFTWARE

The *DemoMedia* software is a demonstrator to showcase the usage of a 2D spatial hypertext system as a platform for browsing sets of multimedia related information. For this demonstrator we wanted to target appropriately large touch-screen devices, thus, we implemented it to run on tablets with Android operating system. The client is part of a greater, server-based system, *Mother*, such that tasks (e.g., spatial parsing or knowledge-base querying) are performed by specialized components in *Mother*. Shifting this functionality to remote services saves computation time and energy for client applications, and makes their implementation easier.

The challenge of organizing information in a two-dimensional space and helping users to find new information is generic to various application domains. Thus, we were able to base development of the *DemoMedia* software on various previous projects in which industry partners, university colleagues, or research team members provided valuable feedback. We were able to consider this for the design of *DemoMedia*.

4.1 Knowledge Base

Supporting the user by giving suggestions is the main task of the *DemoMedia* platform. To do so, the system needs to have knowledge about the domain: movies and contributing staff in our case. This information is stored in a so-called *knowledge base*, a graph database with movies, actors, and directors as entities. Edges are introduced to encode a pairwise relevance score between 0 and 1, where 0 refers to “non-existing” and 1 to “totally relevant to

each other”. The generation of those *weights* happens by analyzing the relationships of actors and movies (acted in). In a first step we collected n movies and their contributors; all entities are added to the knowledge base, weighting the edges among contributors and movies they contributed to with 1. After doing this, the database has no weighted relationships for movies among themselves, thus, those missing links have to be predicted by a suitable algorithm. For the *DemoMedia* demonstrator, we adapted the *Katz* measure [19], such that the sum of weighted paths among two nodes without a relation was normalized to a value fitting in the range from 0 to 1. Simply spoken, two movies are stronger related to each other when they share more contributors. This usually leads to clusters of movies produced in the same decade or serving the same genre, as actors often have roles in particular genres.

The raw data is crawled and computed from *IMDb* (Internet Movie Database) and television program dump provided by *Gracenote*. An evaluation of the demonstrator happened with the *IMDb* data set, containing 6000 entities from which 100 are movies¹ and around 35000 relationships among them.

4.2 User Interface

Spatial hypertext require human interpretations to enable users to visually express and capture complex structures. Therefore, the user interface supports a great degree of freedom for users to organize their thoughts or ideas. Represented by a rectangle, users can freely move, add, delete, or resize them in an infinite space, which can be panned or zoomed. Depending on the visual structure of those nodes, the system generates various suggestions to support the user. Suggestions are laid out into the spatial conditions, such that they augment the user-generated structure and that a human is able to infer the weight of a suggestion from the visual clues (cf. Fig. 6). The positioning and behavior (movement) of suggestions is calculated with the help of physics-based simulations. The underlying model of this simulation is described in [27].

Nodes can represent their content (e.g., a movie) in different ways: with a simple text note, a picture, or a video. This strong integration of the actual content into the application, allows users to consume or to interact with it, without losing the context of their emerging visual structure.

Users can add suggestions to their hypertext by dragging the “+” symbol and dropping the label somewhere on the space. This,

¹The top 100 by user rating (September 2018): https://www.imdb.com/search/title/?genres=drama&groups=top_250&sort=user_rating,desc

(a) Showing three nodes: Spotlight, Toy Story 3, and Brad Pitt; the first two are recognized as visually related by the spatial parser, indicated by the same color [cf. 27]

(b) The spatial parser identifies two structures with three visually related nodes each [cf. 27]

Figure 6: DemoMedia screenshots (photo of Brad Pitt by Dick Thomas Johnson, licensed under CC BY 2.0, extracted and cropped from <https://flic.kr/p/21pNYLs>)

in turn, changes the visual structure, new suggestions are queried and displayed. An iterative process starts, where both human and computer use the visual space as a medium of communication.²

5 CONCLUSION AND FUTURE WORK

The application domain of the presented project is video or film consumption and tasks related to it. With four usage scenarios, we have identified people's needs who select and watch video content for various purposes. We have identified two main problems when using contemporary platforms:

- (1) Note-taking is decoupled from the video platforms, as their structuring capabilities are very limited. Thus, a gap exists between taking notes and selecting/watching videos. This is also true for communicating ideas or discussion items to others.
- (2) The user journey of searching for or selecting a movie/video becomes increasingly frustrating because user ideas cannot be expressed sufficiently easy. Several iterative steps are needed.

We propose hypertext in combination with recommender functionalities to support the users' needs of taking notes or getting support in decision-making processes. We implemented a software demonstrator based on our CB-OHS *Mother*, a specific, movie-related knowledge base, and the client software *DemoMedia*. Furthermore, we have argued that this setup combines note-taking and knowledge creation and supports communication with others. It also reduces the number of steps for selecting videos compared to most contemporary systems and thus eases the selection or decision making process.

This work goes in line with our efforts to support the user with intelligent tools for structuring information [cf. 5], as described by Engelbart as "augmenting human intellect". Future work with respect to *DemoMedia* includes building up a larger knowledge base and better collaboration support such that teams can jointly use the system independent of space and time.

Furthermore, we have demonstrated in various current or past projects that the system can be used for different domains, including software engineering [26] or industry applications [5]. Each of them uses specific features, such as specialized knowledge bases or different sets of structure services (e.g., for supporting spatial, navigational, hierarchical, or metadata structures). It is still a question for investigation which of those features should be included in a tool for selecting videos or building up knowledge from those.

In this work, we have chosen to implement *DemoMedia* for tablet computers. However, when we talk about video content, the question arises how this system can be implemented for smart TVs. Related research questions include the interaction with a spatial hypertext running on a smart TV or the communication between a smart TV and the user's tablet computer ("2nd screen"), including required user interaction patterns. Furthermore, we acknowledge that more user or usability tests need to be conducted to strengthen our analysis or identify its weaknesses. This also includes longterm tests in various scenarios.

Based on our analysis presented in this paper, however, we can conclude that the *DemoMedia* approach is promising for the entertainment industry, in particular the focus on combining recommender, association, and communication functionalities to support users' cognitive tasks at hand, e.g., collecting, structuring, or sharing ideas. It combines both the machine's capability of extracting knowledge from huge amounts of data and the human's capability of sensemaking, intuition, and creativity.

²See the demo video on YouTube: <https://youtu.be/GX53yezHDXE>

ACKNOWLEDGMENTS

This work is part of the project “Car Infotainment”, sub-project “DemoMedia”, funded by the Bavarian State Ministry of Science and the Arts (grant ID 1547-RP-01).

REFERENCES

- [1] Robert M. Akscyn, Donald L. McCracken, and Elise A. Yoder. 1988. KMS: a distributed hypermedia system for managing knowledge in organizations. *Commun. ACM* 31, 7 (1988), 820–835. <http://doi.acm.org/10.1145/48511.48513>
- [2] IfD Allensbach. 2018. Meistgenutzte Informationsquellen der Bevölkerung in Deutschland im Jahr 2018. WWW. <https://de.statista.com/statistik/daten/studie/171257/umfrage/normalerweise-genutzte-quelle-fuer-informationen/>
- [3] Parrot Analytics. 2017. *The Global Television Demand Report*. Technical Report. Parrot Analytics. <https://insights.parrotanalytics.com/hubfs/Resources/whitepapers/Parrot%20Analytics%20-%20The%20Global%20TV%20Demand%20Report%202017.pdf>
- [4] Appinio. 2018. Warum siehst Du Dir Videos auf YouTube an? WWW. <https://de.statista.com/statistik/daten/studie/795686/umfrage/gruende-der-nutzung-von-youtube-in-der-generation-z-in-deutschland/>
- [5] Claus Atzenbeck and Peter Nürnberg. 2019. Hypertext as a Method. In *Proceedings of the 30th ACM Conference on Hypertext and Social Media (HT '19)*. ACM. In print.
- [6] Claus Atzenbeck, Daniel Roßner, and Manolis Tzarakakis. 2018. Mother – An Integrated Approach to Hypertext Domains. In *Proceedings of the 29th ACM Conference on Hypertext and Social Media*. ACM Press, 145–149. <https://doi.org/10.1145/3209542.3209570>
- [7] Claus Atzenbeck, Thomas Schedel, Manolis Tzarakakis, Daniel Roßner, and Lucas Mages. 2017. Revisiting Hypertext Infrastructure. In *Proceedings of the 28th ACM Conference on Hypertext and Social Media 28th ACM Conference on Hypertext and Social Media*. ACM Press, 35–44. <https://doi.org/10.1145/3078714.3078718>
- [8] Tim Berners-Lee, Robert Cailliau, Ari Luotonen, Henrik Frystyk Nielsen, and Arthur Secret. 1994. The World-Wide Web. *Communication of the ACM* 37, 8 (Aug. 1994), 76–82. <http://doi.acm.org/10.1145/179606.179671>
- [9] P. J. Brown. 1987. Turning ideas into products: the Guide system. In *Proceedings of the ACM Conference on Hypertext*. ACM, 33–40. <http://doi.acm.org/10.1145/317426.317430>
- [10] Vannevar Bush. 1945. As we may think. *The Atlantic Monthly* 176, 1 (7 1945), 101–108. <http://www.theatlantic.com/doc/194507/bush>
- [11] Telefilm Canada. 2015. Audiences in Canada: Trend Report. WWW. <https://telefilm.ca/wp-content/uploads/audiences-in-canada-trend-report.pdf>
- [12] Jeff Conklin. 1987. Hypertext: an introduction and survey. *Computer* 20, 9 (1987), 17–41. <http://dx.doi.org/10.1109/MC.1987.1663693>
- [13] Douglas C. Engelbart. 1962. *Augmenting Human Intellect: A Conceptual Framework*. Summary Report AFOSR-3233. Stanford Research Institute. <http://dougengelbart.org/content/view/138>
- [14] SevenOne Media GmbH. 2017. Mobile Video: Kleiner Screen für kurze Unterhaltung. WWW. <https://www.sevenonemedia.de/documents/924471/1111580/Research+Flash+41+Mobile+Video+-+Kleiner+Screen+f%C3%BCr+kurze+Unterhaltung/ba79fc9d-12be-7d9e-4f8e-b6d78f326002>
- [15] Kaj Grønbaek and Randall H. Trigg. 1992. Design issues for a Dexter-based hypermedia system. In *Proceedings of the ACM Conference on Hypertext*. ACM, 191–200. <http://doi.acm.org/10.1145/168466.168525>
- [16] Frank G. Halasz, Thomas P. Moran, and Randall H. Trigg. 1987. NoteCards in a nutshell. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems and Graphics Interface (CHI '87)*. ACM Press, 45–52. <http://doi.acm.org/10.1145/29933.30859>
- [17] Maru/Matchbox; IAB. 2017. Most common reasons for watching video content on a TV with others at home in the United States as of November 2017. WWW.
- [18] Jens Jacobsen. 2013. Customer Journey, User Experience, Maps und der umfassende Blick auf den Nutzer. WWW. <https://www.usabilityblog.de/customer-journey-user-experience-maps-und-der-umfassende-blick-auf-den-nutzer/>
- [19] Leo Katz. 1953. A new status index derived from sociometric analysis. *Psychometrika* 18, 1 (mar 1953), 39–43. <https://doi.org/10.1007/BF02289026>
- [20] Klaus Kuenen. 2018. Persona. *Gabler Wirtschaftslexikon* (2018). <https://wirtschaftslexikon.gabler.de/definition/persona-119156/version-368104>
- [21] Thomas Kupferschmitt. 2018. Onlinevideo-Reichweite und Nutzungsfrequenz wachsen, Altersgefälle bleibt. *Media Perspektiven* 9/2018 (2018). http://www.ard-zdf-onlinestudie.de/files/2018/0918_Kupferschmitt.pdf
- [22] Catherine C. Marshall, Frank G. Halasz, Russell A. Rogers, and William C. Janssen. 1991. Aquanet: a hypertext tool to hold your knowledge in place. In *Proceedings of the 3rd ACM Conference on Hypertext*. ACM, 261–275. <http://doi.acm.org/10.1145/122974.123000>
- [23] SevenOne Media. 2019. Durchschnittliche tägliche Nutzungsdauer von Bewegtbildinhalten in Deutschland vom 1. Quartal 2015 bis zum 1. Quartal 2018 (in Minuten). WWW.
- [24] Norman Meyrowitz. 1986. Intermedia: The architecture and construction of an object-oriented hypemedia system and applications framework. *ACM SIGPLAN Notices* 21, 11 (1986), 186–201. <http://doi.acm.org/10.1145/960112.28716>
- [25] Theodor Holm Nelson. 1999. The Unfinished Revolution and Xanadu. *Comput. Surveys* 31, 4es (Dec. 1999). <http://doi.acm.org/10.1145/345966.346039>
- [26] Daniel Roßner and Claus Atzenbeck. 2018. Spatial Hypertext for End-User Development Tools. In *Proceedings of the 1st Workshop on Human Factors in Hypertext (HUMAN'18)*. ACM, 9–15. <http://doi.acm.org/10.1145/3215611.3215612>
- [27] Daniel Roßner, Claus Atzenbeck, and Tom Gross. 2019. Visualization of the relevance: using physics simulations for encoding context. In *Proceedings of the 30th ACM Conference on Hypertext and Social Media (HT '19)*. ACM. In print.
- [28] Thomas Schedel and Claus Atzenbeck. 2016. Spatio-Temporal Parsing in Spatial Hypermedia. In *Proceedings of the 27th ACM Conference on Hypertext and Social Media*. ACM, 149–157. <http://dx.doi.org/10.1145/2914586.2914596>
- [29] Ben Shneiderman. 1987. User interface design for the Hypertypes electronic encyclopedia (panel session). In *Proceedings of the ACM conference on Hypertext*. ACM, 189–194. <http://doi.acm.org/10.1145/317426.317441>
- [30] Ted Smith and Steve Bernhardt. 1988. Expectations and experiences with HyperCard: a pilot study. In *Proceedings of the 6th Annual International Conference on Systems Documentation (SIGDOC '88)*. ACM Press, 47–56. <http://doi.acm.org/10.1145/358922.358931>
- [31] Mediendaten Südwest. 2019. Durchschnittliche tägliche Fernsehdauer nach Altersgruppen in Deutschland in den Jahren 2007 und 2017 (in Minuten). WWW.
- [32] Voicebot.ai. 2018. mart TV-Marktanteil am gesamten TV-Markt weltweit von 2015 bis 2018. WWW. <https://www.statista.com/statistics/889000/worldwide-smart-tv-market-share/>
- [33] Kirsten Zesewitz. 2018. Very british (2/5) Volkssport Gardening. https://www.deutschlandfunk.de/very-british-2-5-volkssport-gardening.795.de.html?dram:article_id=430998