Journal on Interactive Systems, 2026, 17:1
ISSN: 2763-7719 • doi: 10.5753/jis.2026.7211

Research Paper

Digital Tabletop Interfaces: A Systematic Review of Technological Trends

Gustavo Machado de Freitas [Federal University of Santa Maria | *gmfreitas@inf.ufsm.br*]
Cesar Tadeu Pozzer [Federal University of Santa Maria | *pozzer@inf.ufsm.br*]
Lisandra Manzoni Fontoura [Federal University of Santa Maria | *lisandra@inf.ufsm.br*]

Laboratório de Computação Aplicada, Universidade Federal de Santa Maria, Av. Roraima, n 1000, Camobi, Santa Maria, RS, 97105-900, Brazil.

Abstract. Digital tabletops have long played an important role in human–computer interaction research, serving as rich platforms for tangible interaction, collaboration, and multi-user experiences. Despite their historical relevance, recent work still lacks a consolidated synthesis of how these systems have technically evolved. To address this gap, this article presents a Systematic Literature Review on digital tabletops, with a particular focus on input and output hardware technologies and physical configurations. The review followed a structured protocol and included searches across five major scientific databases, covering studies published between 2001 and 2025. From an initial pool of 1,515 articles, 556 studies were selected for detailed analysis. The findings reveal three technological waves, showing a progression from early projection-based systems to the widespread adoption of embedded displays (LCD/LED), alongside the growing use of sensor-assisted computer vision techniques for input. The results also point to a noticeable decline in research activity after 2015. The study discusses potential causes for this trend, including hardware standardization issues and high implementation costs. Based on the temporal coexistence of this decline with the emergence of Extended Reality ecosystems that address similar spatial and collaborative interaction goals under different terminologies, the study suggests that part of this apparent decline may reflect a shift in research focus rather than the disappearance of tabletop-related concerns.

Keywords: Digital Tabletops, Human–Computer Interaction, Systematic Literature Review

Edited by: Joel dos Santos | **Received:** 17 December 2025 • **Accepted:** 22 June 2026 • **Published:** 09 July 2026

1 Introduction

The widespread adoption of smartphones and tablets has normalized touch-based interaction in everyday computing, reshaping how people access information and communicate with one another. This level of accessibility and portability, however, did not happen overnight. The idea of interacting with the digital world through touch has deeper roots, often explored in larger and less compact forms [Buxton, 2025].

Before touch-sensitive screens became widespread in personal devices, digital tabletops had already marked an important step in the study of tangible and collaborative interaction [Dietz and Leigh, 2001]. With their large interactive horizontal surfaces, these systems created opportunities to explore multi-user interaction, direct data manipulation, and the integration of physical objects into digital environments.

The origins of this concept can be traced back to the 1940s, with Vannevar Bush's Memex proposal [Bush, 1996]. By the 1980s, direct interaction with computer systems had become a central topic in Human-Computer Interaction (HCI) [Hutchins *et al.*, 1985; Buxton, 2025]. These developments converged in the early 1990s with the appearance of the first digital tabletops [Wellner, 1991].

Since then, different approaches have shaped tabletop design, keeping pace with advances in input and display technologies. Müller-Tomfelde and Fjeld [2010] described three main transitions: (1) the move from laboratory prototypes to real-world applications in the late 1990s, made possible by projection and vision-based systems such as BUILD-IT [Rauterberg *et al.*, 1998] and the first InteracTable [Streitz *et al.*, 1999, 2001]; (2) advances in input, evolving from single-touch to multitouch and tangible interaction, illustrated by DiamondTouch [Dietz and Leigh, 2001] and later work on gestures and collaboration [Wu and Balakrishnan, 2003; Inkpen *et al.*, 2002; Shen *et al.*, 2009]; and (3) the shift from projectors to embedded displays, as in the second generation of the InteracTable [Streitz *et al.*, 2002]. This technological transition was discussed by Kunz [2011], who detailed some hardware challenges, such as shadow-casting and ergonomic issues, that drove the development of LCD-based systems.

While these systems have had a strong impact on HCI research, there has been a decline in interest in tabletops in recent years. Some studies revisit and map previous work [Scott *et al.*, 2003; Müller-Tomfelde and Fjeld, 2010; Bellucci *et al.*, 2014; Ahsanullah *et al.*, 2015; Costa *et al.*, 2023; Rodić and Granić, 2022], but none provide a recent review that focuses specifically on the technical and hardware aspects of these interfaces.

Understanding this technological trajectory is not merely a historical exercise, it is a necessary baseline for modern HCI. As collaborative paradigms shift toward multi-device and Extended Reality (XR) ecosystems, comprehensively mapping how tabletop hardware evolved is important for informing future architectural frameworks aimed at porting or migrating these legacy collaborative applications into modern environments.

In light of this, we conduct a Systematic Literature Review (SLR) to examine the current state of digital tabletop interfaces. Our goal is to identify which construction approaches remain in use, whether new technological changes have occurred in the last decade, and whether research activity in this field is still sustained.

The remainder of this paper is organized as follows: Section 2 reviews prior work and highlights how existing surveys differ from ours. Section 3 describes the methodology, including the selection protocol, databases, and data extraction. Section 4 presents the results and discusses the trends we observed. Finally, Section 5 addresses the discussion about our findings and study's limitations, while Section 6 wraps our conclusions and outlines future research directions.

2 Related Works

This section presents and analyzes previous works that have addressed the survey of digital tabletop interfaces. The aim is to contextualize the present study, highlighting methodological and topic gaps that justify conducting this SLR. The works are organized chronologically and grouped according to their methodological or area contribution in relation to the scope of this article.

2.1 Technical and Technological Reviews of Tabletops

We start with the work of Scott *et al*. [2003], whose purpose was to derive guidelines for the collaborative interface design in co-located environments. The analysis combined multiple sources, ranging from technical literature in HCI and Computer-Supported Cooperative Work (CSCW) to observational studies involving traditional media and the authors' own practical experiences, in order to understand how the properties of these systems affected collaboration. The study introduced a functional taxonomy of devices, dividing them into four categories: digital desks, which combine digital and paper media at a personal workspace; workbenches, offering semi-immersive environments; drafting tables, designed as inclined surfaces for individual use; and collaboration tables, intended to support small-group interaction. The main emphasis was placed on collaboration tables, while considering useful features from the other three types to improve their design.

As this work dates back to 2003, it does not incorporate the technological advances that occurred in the subsequent decades, such as the emergence of commercial tabletop devices (e.g., Microsoft Surface). Furthermore, the article does not employ formal selection criteria nor describe a search structure, which limits its reproducibility.

Nevertheless, the proposed taxonomy provides a valuable conceptual foundation for this study. It has been simplified and expanded to incorporate not only user-number categories (single-user and co-located collaboration) but also the contemporary concept of remote collaboration, which is increasingly common in network-connected tabletop interfaces.

Bellucci *et al*. [2014] conducted one of the most comprehensive studies on tabletop computing, examining interaction modalities, available hardware technologies, and input spaces associated with interactive horizontal surfaces. Their goal was to provide a consolidated view of the field's development up to that point, highlighting trends, challenges, and opportunities for fostering more natural interactions in tabletop interfaces. The study also aimed to establish a classification framework to support researchers and developers in analyzing and designing new tabletop systems.

The authors primarily collected studies through Google Scholar, using search terms such as tabletop, interactive table, interactive desk, and horizontal surface. They also supplemented their dataset with key references, including Bill Buxton's compendium on multi-touch [Buxton, 2025] and the historical overview of Müller-Tomfelde [2010]. While the study did not follow a formal, systematic approach, the authors applied implicit selection criteria: they included only tabletop systems with sufficient technical detail—both in hardware and interaction design—and excluded vertical, mobile, or wall-mounted displays that do not directly affect the horizontal surface experience.

The study's main contribution lies in the taxonomy proposed to characterize tabletop systems, organized into five dimensions: (1) type of display (front-projected, rear-projected, embedded); (2) surface orientation (horizontal or inclined); (3) display scale; (4) usage context (individual or co-located); and (5) input modality (touch, tangible, touchless).

This framework has been particularly influential in shaping the present SLR, serving as a conceptual reference for mapping the technical characteristics of the systems under analysis. Although it lacks the methodological rigor of a systematic review and its data are somewhat outdated given technological advances over the past decade, the work of Bellucci et al. remains an essential reference for historical context and for longitudinal comparison with our findings.

Ahsanullah *et al*. [2015] provide a comprehensive overview of the technologies used in multi-touch tabletop systems, with a particular focus on input detection mechanisms. Although it does not follow the methodological rigor of an SLR, the work reviews a wide range of relevant publications in HCI and CSCW, classifying them into three axes: (1) by detection technology, such as capacitive, optical, and computer vision–based systems; (2) by application domain, including areas such as education, medicine, urban planning, and entertainment; and (3) by technical and human challenges faced by these devices. A notable contribution of the article is the distinction between purely vision-based systems, which use only traditional cameras and image processing algorithms, and optical and vision-based systems, which combine computer vision with auxiliary techniques such as infrared (e.g., FTIR, DI) or depth sensors (e.g., Kinect).

Although the article focuses on the multi-touch domain, it provides valuable information that directly informed the data extraction form of this SLR, especially in relation to the categorization of input technologies. Published in 2015, the study is relatively recent within the temporal scope of the field; however, its overview nature—lacking explicit inclusion and exclusion criteria or a formal systematic methodology—limits its applicability. Nevertheless, the work explicitly highlights the shortage of systematic reviews in the tabletop computing literature, reinforcing the necessity of the present study.

2.2 Application-Focused Systematic Reviews

Rodić and Granić [2022] presents an SLR focused on Tangible User Interfaces (TUIs) applied to early childhood education, considering studies published between 2001 and 2019. The adopted protocol is detailed, including the databases used, search strings, and inclusion and exclusion criteria, making it a relevant methodological reference. The authors classify the identified works based on three main dimensions: (a) the form of the tangible object — divided into manipulatives (physical blocks and toys), tabletops (interactive digital tables), and tablets (mobile devices with touch-sensitive screens); (b) the educational application domain; and (c) a descriptive assessment of the impact and type of interaction promoted by the analyzed devices.

Although the scope of the study is centered on the field of education and does not delve into the technical aspects of hardware or the physical configuration of tabletop systems, its relevance to the present SLR is twofold. First, it demonstrates a rigorous methodological application in a tangentially related context, serving as an example of data structuring and categorization. Second, it offers insights into the evolution of academic interest in TUIs, noting that most studies in the area were published in the last decade — information that reinforces the historical narrative of the diffusion and consolidation of tabletop systems.

Costa *et al*. [2023] provide a recent contribution to the literature on tangible tabletops through a SLR that focuses on applications using tangible interfaces on interactive digital tables. Their review aimed to outline the state of the art over the past five years, examining usage patterns, design methodologies, and challenges encountered by interactive applications in this domain. For this SLR, their main contribution lies in the detailed description of the methodological protocol, including databases, search strings, and inclusion and exclusion criteria.

In their analysis, Costa et al. concentrate on usability and HCI aspects, classifying applications by usage context, target audience, touch recognition techniques, and interaction modalities, with particular attention to tangible tokens. They address the hardware dimension only superficially, treating it as functional support rather than a primary focus. The authors also manually included additional articles. While this approach increases the number of studies considered, we decided not to adopt it in the present work in order to preserve reproducibility and transparency. Nonetheless, their methodological framework and analysis categories provide a solid foundation for constructing and validating the protocol used in this SLR.

Overall, the reviewed studies offer different perspectives on tabletop interfaces, spanning technical, methodological, and applied viewpoints. However, none systematically examines the technological evolution of the physical components of these interfaces, particularly in terms of hardware architectures and input/output modalities. This gap motivates the present SLR, which focuses specifically on the technological analysis of digital tabletops.

3 Methodology

This section presents the methodology used to conduct this SLR, following the guidelines proposed by Kitchenham and Charters [2007], which are widely recognized in software engineering and also applicable to reviews in HCI. Our goal is to ensure transparency, rigor, and reproducibility throughout the process. We conducted the research between March and June 2025, and carried out the data extraction phase in April using the Parsifal platform[1], which facilitates the organization and documentation of SLRs.

A systematic literature review is a structured approach to surveying and analyzing scientific publications, designed to answer specific research questions through a well-defined and reproducible protocol. In this study, we followed the SLR protocol proposed by Kitchenham and Charters [2007], which structures the review into three main phases: planning, conducting, and reporting.

- **Planning.** In this phase, we defined the scope of the study and formulated the research questions to guide the review (see Section 3.1).
- **Conducting.** We carried out a systematic search across multiple scientific databases, then applied predefined inclusion and exclusion criteria to select relevant studies. Finally, we extracted and processed data from the selected articles, organizing the information to address the research questions (see Section 3.2).
- **Reporting.** This phase involved presenting the methodology, analysis, and results of the review in a transparent and reproducible manner, following the standards recommended for systematic literature reviews (see Section 4).

3.1 Planning Phase

To address the gaps identified in the literature, this review was guided by a technological scope, focusing on investigating the technological landscape of digital tabletops over the years, mapping the types of hardware used, physical configurations, input/output modalities, among other characteristics. We formulated the following research questions to achieve this goal:

- **RQ1:** Which types of hardware are commonly used for information display?
- **RQ2:** What techniques are employed to capture user input?
- **RQ3:** Which user interaction modalities are supported by these technologies?

3.2 Conducting Phase

After defining the research topic, we formulated the following search string to identify relevant publications in the field:

> **("digital tabletop" OR "tabletop interface" OR "tangible tabletop" OR "horizontal interactive surface") AND ("hardware" OR "technology" OR "projector" OR "display") AND ("touch" OR "tangible" OR "interaction" OR "collaboration")**

The choice of these terms was derived from the research questions and refined using terminology identified in foundational surveys, such as the taxonomy proposed by Bellucci *et al*. [2014]. Initially, key concepts were extracted from the research questions and grouped into three conceptual blocks:

[1] `https://parsif.al`. Accessed on 27 June 2026.

the target platforms, the technical focus, and interactions. These terms were then expanded with synonyms and related expressions identified in the literature, and combined using Boolean operators to form the final search string.

We adopted a broader formulation of the search string, prioritizing OR operators over AND to maximize coverage and include studies that use diverse terminologies and emphasize different aspects of the field. We then conducted searches across the following scientific databases: ACM Digital Library[2], IEEE Xplore Digital Library[3], ScienceDirect[4], Scopus[5] and Springer Link[6]. These databases were selected because they represent the most comprehensive repositories for peer-reviewed literature in HCI. Following the editorial recommendation, we also performed a complementary search in SBC OpenLib/SOL[7] to verify whether relevant studies indexed in the Brazilian Computer Society's repository had been overlooked. No additional English-language studies meeting the inclusion criteria were identified. We made minor syntactic adjustments to the search string on each platform to comply with the respective indexing systems.

3.2.1 Study selection

We defined explicit inclusion and exclusion criteria to ensure the relevance and quality of the selected studies. We included articles that met at least one of the following conditions:

- **IC1:** Presented or described digital tabletop hardware;
- **IC2:** Reported applications developed for digital tabletop interfaces, explicitly mentioning the hardware used;
- **IC3:** Evaluated or analyzed the performance, usability, or characteristics of digital tabletop hardware.

At the same time, we applied the following exclusion criteria to refine the research corpus:

- **EC1:** Articles that did not focus on specific hardware or omitted hardware details;
- **EC2:** Duplicate studies across different databases;
- **EC3:** Incomplete publications, such as posters, extended abstracts, preliminary reports, and workshop proceedings without full text;
- **EC4:** Works addressing non-interactive digital tables or those with interaction limited to conventional mouse and keyboard use;
- **EC5:** Articles not directly related to technologies concerning digital tabletops;
- **EC6:** Publications written in languages other than English.

We systematically carried out the article selection process in multiple stages using the Parsifal tool. First, we removed duplicates resulting from overlaps among the databases. Next, we conducted an initial screening based on abstracts to exclude incomplete publications and articles that fell outside the thematic scope.

[2]`http://portal.acm.org`. Accessed on 27 June 2026.
[3]`http://ieeexplore.ieee.org`. Accessed on 27 June 2026.
[4]`http://www.sciencedirect.com`. Accessed on 27 June 2026.
[5]`http://www.scopus.com`. Accessed on 27 June 2026.
[6]`http://link.springer.com`. Accessed on 27 June 2026.
[7]`https://sol.sbc.org.br/busca/`. Accessed on 27 June 2026.

In the final stage, we performed an in-depth analysis of each article selected during the preliminary screening. This thorough reading allowed us to apply the inclusion and exclusion criteria rigorously, ensuring that the studies were relevant and aligned with the central objective of this systematic review. The first author conducted the screening process. When a study presented ambiguous eligibility conditions, such as incomplete hardware descriptions or uncertainty regarding its alignment with the review scope, the case was discussed with the co-authors. These discussions focused on the interpretation of the predefined inclusion and exclusion criteria rather than on establishing new criteria. The final decision was reached through consensus after jointly examining the relevant sections of the article and verifying its compliance with the review protocol. The study selection flow is summarized in Figure 1.

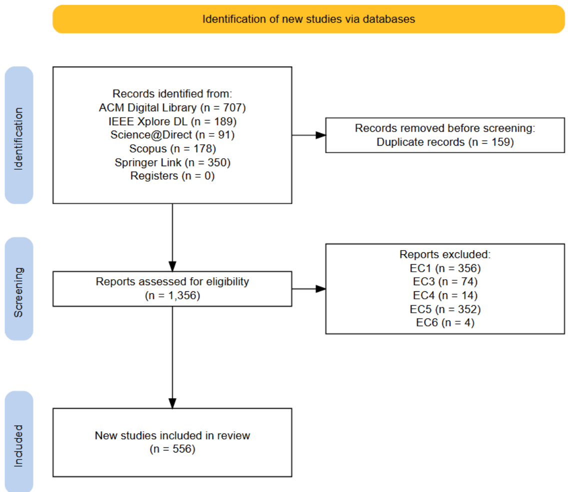

Figure 1. Flow of study selection included in the systematic review.

The search process identified 1,515 articles, of which we selected 556 for data extraction according to the criteria described in the methodology section. In the following analysis, we discuss the criteria that guided article acceptance or rejection, as well as the temporal trends observed across the reviewed studies.

The most frequent exclusion criterion during screening concerned the lack of a clear focus on a specific hardware platform. We excluded a total of 356 articles (44.5% of rejected studies) for failing to describe the technical aspects of a single digital tabletop in sufficient detail. This group included studies addressing broader topics in HCI related to digital tabletops without specifying the hardware [Scott *et al.*, 2004; Derboven *et al.*, 2010; O'hara *et al.*, 2011; Vennelakanti *et al.*, 2011; Mendoza *et al.*, 2012; de Souza Alcantara *et al.*, 2013; Hamdan *et al.*, 2013; Harley *et al.*, 2016; Lin *et al.*, 2016; Da Costa *et al.*, 2018], as well as works that generically referenced multiple platforms, such as surveys or software descriptions [Hinrichs *et al.*, 2007; Shirazi *et al.*, 2009; Kaltenbrunner, 2009; Zappi *et al.*, 2009; Ghanam *et al.*, 2010; Silva *et al.*, 2014; Davis *et al.*, 2015; Nasir *et al.*, 2021]. This filtering ensured consistency in our analysis by retaining only studies with a technical focus on a specific tabletop configuration.

The second most common exclusion criterion involved

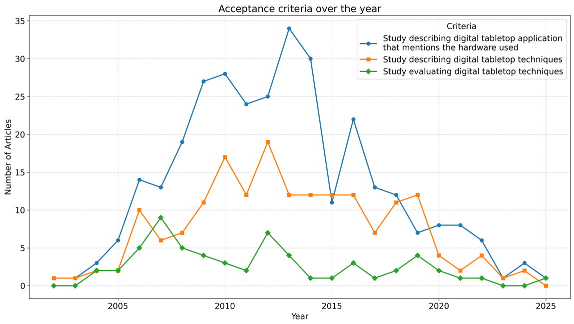

Figure 2. Accepted articles per year according to the criterion.

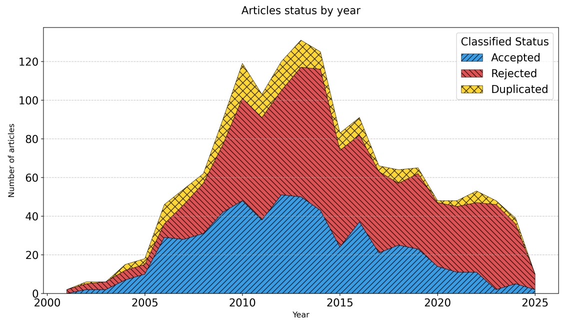

Figure 3. Articles classified by year.

articles whose content did not relate to digital tabletop interfaces, totaling 352 exclusions (43% of rejected studies). This outcome reflects the deliberately broad strategy used in formulating the search string. As a result, many retrieved articles mentioned the search terms in contexts unrelated to tabletops. Manual semantic filtering allowed us to exclude these works, keeping only studies that explicitly addressed horizontal interactive surfaces.

Among the accepted articles, 68% describe applications developed for existing platforms, mentioning the hardware used, but without focusing primarily on its construction. This pattern reflects the field's practice of reusing digital tabletops as a foundation for interaction experiments. Notably, 179 articles (32%) provide detailed hardware descriptions, either presenting novel platforms or proposing modifications to existing systems.

This trend aligns with observations by Sheridan *et al.* [2009], who noted a predominance of custom-made systems developed by research groups in the late 2000s. Earlier, Scott and Carpendale [2006] highlighted the lack of standardization as a barrier to broader dissemination of tabletop research. The emergence of commercial platforms, expected to mitigate this limitation, began materializing around 2012, as suggested by the temporal data shown in Figure 2.

Examining both accepted and rejected articles, as shown in Figure 3, reveals a pronounced peak in publications between 2010 and 2014. Since 2015, there has been a continuous decrease in the number of studies on digital tabletops.

3.2.2 Data extraction

After completing the final selection of studies, we carried out the data extraction phase using a structured form, as shown in Table 1. We designed the form to capture the main technological characteristics of the analyzed digital tabletop systems, focusing on hardware aspects, interaction modalities, and usage configurations.

We defined each field based on its informational nature and the recurrence of data observed in the literature. We classified fields as multiple choice when a system could include multiple values (e.g., technologies combining touch and tangible tokens), and as free text (string) when we could not predict or delimit the possible categories in advance. The following provides detailed descriptions for each field:

- **Display technology** (multiple choice): Refers to the method used for visual interface presentation. Options include:
  - *Embedded*: displays integrated directly into the table surface (e.g., LCD, LED, OLED);
  - *Headset*: use of head-mounted displays for visualization;
  - *Multi-Device*: integration of multiple devices (e.g., tablets or smartphones connected to the table);
  - *Rear-Projected*: projection from beneath the surface;
  - *Front-Projected*: projection onto the surface from above.
- **Input capture technology** (multiple choice): Represents sensors and techniques used to detect user input:
  - *Pen*, *Tangible-Tokens*, *Wearables*: input mediated by physical objects or specific devices;
  - *Electrical-Based*: electronic sensors (e.g., capacitive/resistive) embedded in the surface detecting direct physical contact;
  - *Pure-Vision-Based*, *Sensor-Assisted-Vision-Based*, *Sound-Based*: techniques based on recognition through image, light, or sound;
  - *Eye-Tracking*.

  It is worth noting that some systems classified as tangible did not include pen or tokens. This indicates that generic objects were recognized via software without requiring explicit marking.
- **Supported interaction type** (multiple choice): Interaction modalities enabled by the system:
  - *Touch*, *Multi-touch*, *Gesture*, *Speech*, *Tangibility*, *Gaze*.
- **Collaboration** (multiple choice): Classification of the collaborative scenario provided:
  - *Single user*: system designed for individual use;
  - *Co-located collaboration*: multiple users in the same physical space;
  - *Remote collaboration*: support for synchronous interaction at a distance.
- **Uses specific model?** (string): Free-text field for identifying architectural models explicitly mentioned in the system development, as well as commercial platforms or devices used (e.g., DiamondTouch, Microsoft Surface, Samsung SUR40).
  Additionally, when articles only mentioned the commercial name of the tabletop used, known technical specifications of these devices were retrieved from reliable secondary sources to complete the relevant form

Table 1. Fields and data types of the extraction form.

Field	**Type**	**Values**
Display technology	Multiple choice	Embedded, headset, multi-device, rear-projected, front-projected.
Input capture technology	Multiple choice	Pen, eye-tracking, sound-based, electrical-based, sensor-assisted vision-based, tangible tokens, pure vision-based, wearables.
Supported interaction type	Multiple choice	Gaze, gesture, multi-touch, speech, tangibility, touch.
Collaboration	Multiple choice	Co-located collaboration, remote collaboration, single user.
Uses specific model?	String	n/a.
Table size	String	n/a.

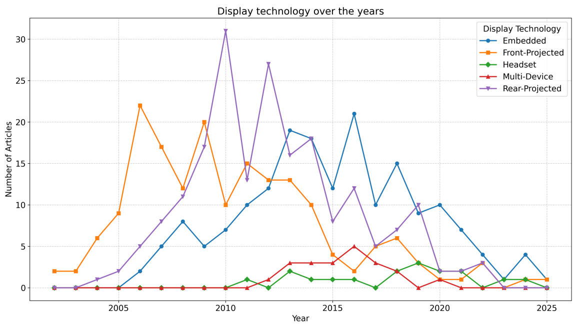

Figure 4. Temporal distribution of display technologies used in digital tabletop systems.

fields, ensuring data completeness.

- **Table size** (string): Free-text field referring to the physical dimensions of the interactive surface. To ensure consistency and comparability, extracted data were normalized to express the *table diagonal in inches*, given that studies reported measurements in various formats (width/height, diagonal, centimeters, or inches). Conversions were applied as necessary.

For reproducibility purposes, the complete dataset containing the analyzed works, applied filters, and extracted data are publicly available online[8].

4 Results and Analysis

This section presents the main findings of the review, combining a quantitative overview of the extracted data with an analysis of their implications. We organize the results thematically, covering aspects from article screening and selection to the technical characterization of the analyzed tabletop systems.

4.1 Extracted Data

This subsection presents the data we extracted from the 556 selected articles, based on the fields defined in the extraction form described in the methodology section (Table 1). For each analyzed attribute, we generated distribution charts over time, allowing us to observe technological trends and transitions.

4.1.1 *Display Techniques*

Figure 4 illustrates the evolution of major display technologies adopted in digital tabletop interfaces over the years. We can identify three significant technological “waves,” marking distinct phases in the field’s development. Initially, front-projection dominated, with notable systems such as DiamondTouch and UbiTable [Dietz and Leigh, 2001; Shen *et al.*, 2003, 2004; Sluis *et al.*, 2004; Moher *et al.*, 2005] widely used from the late 1990s through the mid-2000s. Rear-projection then gained prominence due to its higher precision and reduced occlusion, as seen in systems like reacTable and U-Table [Jordà *et al.*, 2006; Lee and Kim, 2006; Bredies *et al.*, 2008; Bartindale *et al.*, 2009]. From 2010 onward, researchers increasingly adopted embedded displays, particularly LCD panels combined with capacitive multitouch technology [Ahn *et al.*, 2010; Cheng *et al.*, 2010; Clayphan *et al.*, 2011; Ahn *et al.*, 2012; Bortolaso *et al.*, 2013; Antle *et al.*, 2013].

The emergence of new technologies did not imply the abandonment of previous ones. Although embedded displays have become the dominant solution since the 2010s, recent studies within the last five years still employ front-projection. This persistence likely reflects the lower cost and flexibility of projectors, especially in contexts where projection visually augments physical objects on the surface, as in systems exploring projection-augmented tangibility [Clarinval *et al.*, 2021; Marlier *et al.*, 2025; Kuwahara and Umezu, 2021]. This trend suggests that in some applications, adaptability and technical accessibility take precedence over display sophistication.

We also observed that multi-device setups and Virtual Reality (VR) headsets have not appeared prominently in the analyzed works. It does not indicate incompatibility with collaborative interactions; on the contrary, recent studies highlight their potential in this domain [Pidel and Ackermann, 2020; Van der Meer *et al.*, 2023; Paulsen *et al.*, 2024]. However, these technologies have developed under different paradigms and terminologies, often outside the traditional vocabulary of tabletop computing. As a result, searches using terms such as “horizontal interactive surface” or “digital tabletop” may not capture them, despite their shared principles of spatial interaction and collaboration.

Consequently, solutions that could be considered a continuation or transformation of the original interactive tabletop concept remain largely undetected. This observation supports the hypothesis that research in collaborative HCI may be shifting toward other technological domains, such as immersive environments or interconnected ecosystems, without this transition being visible in mappings based on classical tabletop terminology.

4.1.2 *Input Techniques*

The temporal distribution of input capture techniques, shown in Figure 5, reveals a landscape dominated by computer vision-based approaches, particularly sensor-assisted systems. We classify this category as *Sensor-Assisted-Vision-Based*, which

[8] `https://github.com/Guglis02/Tabletop-Data-Extraction`. Accessed on 27 June 2026.

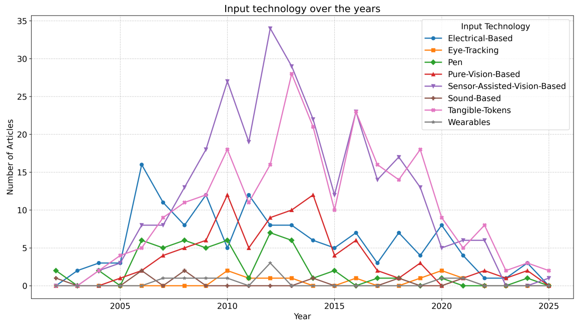

Figure 5. Temporal distribution of input capture technologies used in digital tabletop systems.

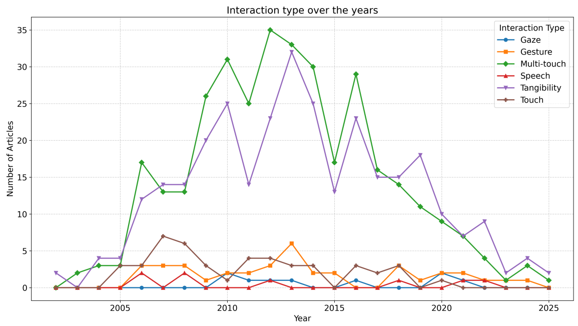

Figure 6. Temporal distribution of interaction types supported by digital tabletop systems.

includes techniques such as FTIR, DI, and depth sensors (e.g., Kinect). Aggregating these technologies under a single category highlights general adoption trends while masking the relative weight of each technique. In contrast, even when combining capacitive and resistive sensors into the *Electrical-Based* category, these methods occur less frequently across the two decades analyzed.

We also adopted the distinction proposed by Ahsanullah *et al*. [2015] between pure computer vision systems (*Pure-Vision-Based*), which rely exclusively on RGB cameras and image processing, and systems assisted by auxiliary sensors. This differentiation helps clarify nuances in computer vision usage over time. For instance, purely visual systems showed significant adoption between 2008 and 2014, followed by a sharp decline, whereas systems with optical sensor support demonstrated greater longevity.

Other input techniques, including *Tangible Tokens*, *Pen-Based*, and *Wearables*, maintained a more modest but consistent presence, suggesting applications in specific niches. The introduction of eye-tracking technology in a limited number of studies is indicative of future exploration opportunities. The temporal distribution also highlights the flexibility of tabletop systems in supporting multiple input modalities, which reinforces their adaptability but complicates systematic categorization. We further discuss these limitations in the discussion section and in the concluding remarks on the adopted methodological protocol.

4.1.3 *Interaction Support*

Figure 6 shows the temporal distribution of interaction types supported by digital tabletop systems. To improve clarity, systems that supported both multi-touch and touch were grouped under multi-touch, allowing a clear separation of cases limited to single-point contact. The data indicate that multi-touch and tangibility dominated the field. Multi-touch gained prominence by enabling expressive gestures, complex manipulations, and simultaneous interaction among multiple users in the same physical space.

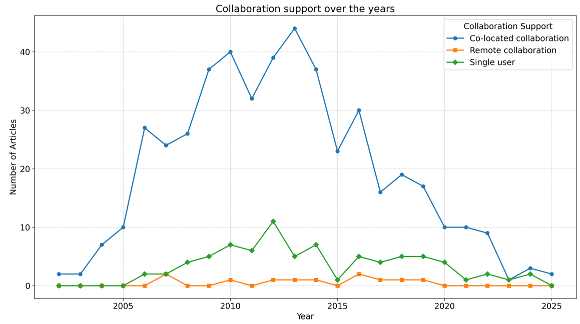

Figure 7. Temporal distribution of collaboration support in digital tabletop systems.

Tangibility remained central to tabletop interfaces, incorporating physical objects as input mechanisms. This category includes tokens with fiducial markers or RFID antennas, generic objects recognized through computer vision, as well as the use of pens (e.g., stylus, active pen, Anoto pens), and active devices that communicate with the surface. Other modalities, including gesture, speech, and gaze, appeared less frequently. Although these techniques offer more natural forms of interaction, their adoption has stayed mostly restricted to specific or experimental applications.

4.1.4 *Collaboration*

Figure 7 shows the evolution of collaboration modes supported by digital tabletop systems. Although platforms designed for co-located use can also accommodate individual interaction, the single-user category includes only systems explicitly conceived for solitary operation. Likewise, systems supporting remote collaboration were grouped exclusively under this category, even when they also enabled co-located interaction, to ensure analytical distinction.

The results highlight the predominance of co-located collaboration, consistent with the original conception of tabletops as shared surfaces fostering simultaneous interaction in the same physical space. Around 14% of the systems were designed for single users, reflecting a more restricted exploitation of the technology's collaborative potential. Only 2% supported remote collaboration, indicating its marginal presence. This limited adoption likely stems from the low commercial dissemination of tabletops, which reduced incentives to develop remote infrastructures for geographically distributed groups. These findings reinforce the idea that the tabletop paradigm remains strongly tied to co-located contexts [Hong *et al*., 2008], while its collaborative legacy may be reconfigured by emerging technologies such as immersive VR.

4.1.5 *Specific Models*

Figure 8 presents the most recurrent digital tabletop models reported in the analyzed articles. For visualization purposes, the figure includes only models cited in more than four studies. In total, 53% of the works explicitly mention the model used.

The main identified platforms are summarized below:

- **DiamondTouch** – Mitsubishi Electric Research Laboratories (MERL), Boston, developed in 2001, marking one of the first multi-user tabletops in the current sense

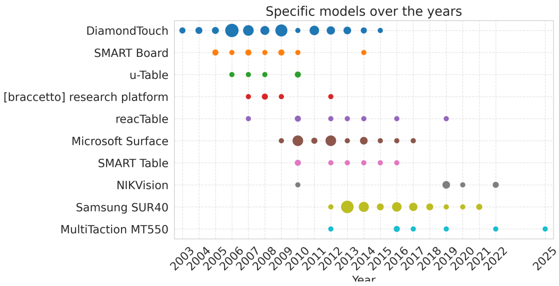

Figure 8. Main specific models mentioned in the articles.

[Dietz and Leigh, 2001]. The distribution of prototypes to research institutions fostered wide academic adoption. From 2009, CircleTwelve assumed its commercialization [Circle Twelve, 2013].

- **SMART Board** – A line of interactive whiteboards launched by SMART Technologies in the late 1990s. Although designed for vertical use, it was employed in various studies as a horizontal interactive surface [Ishido *et al.*, 2007].
- **u-Table** – Platform developed in South Korea in 2006, featuring its own infrared-based input detection system [Lee and Kim, 2006].
- **[braccetto] research platform** – Australian research tabletop created in the early 2000s, combining an LCD-based horizontal screen with a vertical display for conferencing [Schremmer *et al.*, 2007].
- **reacTable** – Developed in Barcelona in 2005 with the initial aim of being a collaborative musical instrument [Kaltenbrunner *et al.*, 2006]. It uses *tokens* as the main interaction method and was accompanied by the development of the *reacTIVision* framework for visual marker detection[9]. A digital version is currently available for mobile devices[10].
- **Microsoft Surface** – Launched in 2008 as one of the first commercial initiatives in the tabletop domain [Bellucci *et al.*, 2014]. It was based on internal projection combined with the optical *Diffuse Illumination* (DI) technique for touch detection [Schöning *et al.*, 2008].
- **SMART Table** – A line of commercial digital tables also developed by SMART Technologies, mainly aimed at the educational context.
- **NIKVision** – Table developed in 2008 at the University of Zaragoza, targeted at children [Marco *et al.*, 2008]. It supports tangible interaction through *tokens* and uses projectors for visual feedback, alongside a complementary vertical monitor.
- **Samsung SUR40** – Released in 2012 in partnership with Microsoft, it replaced the DI system with an LCD screen featuring Microsoft PixelSense capacitive technology, allowing a significant reduction in device thickness.
- **MultiTaction MT550** – Commercially launched in 2012 by MultiTaction[11], it uses proprietary infrared-based technology for input capture directly on an LCD panel.

Different adoption cycles are evident in the temporal distribution of these platforms, with some systems, such as DiamondTouch, remaining influential for more than a decade, others, as Microsoft Surface and Samsung SUR40, represent commercial initiatives that initially generated impact but gradually lost traction.

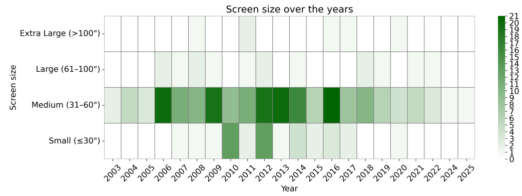

Figure 9. Display sizes of tabletops over the years.

4.1.6 *Display Sizes*

Figure 9 shows the temporal distribution of display size ranges, grouped to facilitate visualization. Most platforms fall within the medium range (31”–60”), with an overall average of 45.88” among the cases that report size data. Large displays (>100”) appear rarely, as in the u-Table, which combines multiple projectors to reach 169” of interactive surface [Qin *et al.*, 2011].

Only 49.5% of the analyzed articles specify display size, which restricts the scope of this analysis. Even so, widely adopted commercial models such as Microsoft Surface (30”) and Samsung SUR40 (40”) reinforce the medium range as a standard for ergonomic and operational comfort. Li *et al.* [2012] highlight that large displays can introduce ergonomic barriers, limiting continuous interaction and causing fatigue in prolonged usage contexts.

5 Discussion

The results of this study reveal several patterns and temporal trends in the evolution of digital tabletop systems in relation to the research questions. As questioned by RQ1, analysis of display hardware reveals three main technological waves: front-projection, rear-projection, and embedded displays such as LCD and LED panels. Although embedded displays have become dominant, projection-based approaches continue to be used, particularly in contexts that combine visualization with manipulation of physical objects. Medium-sized commercial models, such as the Microsoft Surface and Samsung SUR40, illustrate how ergonomic and operational considerations have influenced platform design, while large setups remain niche solutions [Li *et al.*, 2012]. These findings indicate that application context and requirements primarily determine display choices, rather than a linear technological progression.

In relation to RQ2, sensor-assisted computer vision techniques—including FTIR, DI, and depth sensors—dominate the landscape of input capture as purely visual systems, tangible tokens, and capacitive or resistive sensors appear less frequently. Eye-tracking, sound-based capture, pens, and wearables are emerging approaches that occur sporadically.

Multiple input techniques can be combined to demonstrate the adaptability and capacity of digital tabletops for complex interactions. Regarding supported interaction modalities [RQ3], multi-touch and tangibility remain the most prevalent, enabling expressive gestures, simultaneous multi-user interaction, and the use of physical objects as input channels. Less frequent modalities, including gestures, speech, and gaze, ap-

[9] `https://reactivision.sourceforge.net/`. Accessed on 27 June 2026.
[10] `https://reactable.com/mobile/`. Accessed on 27 June 2026.
[11] `https://multitaction.com/`. Accessed on 27 June 2026.

pear primarily in specialized or experimental applications. These patterns highlight the balance between well-established interaction paradigms and emerging techniques designed to enhance user experience.

Temporal analysis shows that technologies do not replace each other linearly but often coexist and combine in hybrid systems. Some platforms integrate RGB cameras for color recognition, infrared sensors for spatial tracking, and pressure sensors for touch force [Fujinami *et al.*, 2018]. The lack of convergence toward a single technological standard reflects the exploratory and context-specific nature of tabletop computing. While single-user and remote collaboration systems are less frequent, co-located collaboration still dominates. Emerging technologies such as immersive VR and interconnected ecosystems may be shifting research focus beyond classical tabletop interfaces, a transition partially hidden by terminological separation.

Overall, the findings illustrate technological diversity: display and input techniques evolve through coexistence and hybridization, interaction modalities remain centered on multi-touch and tangibility, and collaboration is primarily co-located. Rather than a limitation, this diversity represents a structural characteristic of the field, underscoring the adaptive and exploratory nature of tabletop computing. These insights support the research objectives by providing a comprehensive understanding of the current landscape and guiding future work on context-aware and novel interaction systems.

It is important to highlight that the data from this SLR show a marked decline in publications on digital tabletop interfaces after 2015, interrupting the growth observed between 2010 and 2014. The literature has not yet systematically explored the causes of this trend. Studies published during the growth period already identified factors such as the lack of hardware standardization [Scott and Carpendale, 2006], the high cost of developing and maintaining physical platforms [Sheridan *et al.*, 2009], and ergonomic challenges during prolonged use [Li *et al.*, 2012] as obstacles to the widespread adoption of tabletops. Despite these challenges, it remains unclear to what extent technical limitations directly influenced the decrease in academic interest.

Moreover, a plausible explanation involves a shift in research focus toward emerging interaction technologies, including VR, AR, and multi-device ecosystems. These technologies share the spatial and collaborative interaction goals of tabletops but have developed under distinct terminologies and usage contexts. Consequently, publications in these areas may not appear in searches based on traditional tabletop computing terminology, even though they pursue similar objectives.

While this study does not provide definitive evidence regarding the decline in tabletop publications, it underscores the need for complementary research to investigate these transitions using more open methodologies. Future work could explore explicit connections between the tabletop research trajectory and recent developments in immersive technologies, assessing whether conceptual continuity exists between these domains. In this way, the original vision of shared interactive surfaces may not have been abandoned, but rather modified, reflecting the field's evolution toward new technological platforms.

Regarding the future of digital tabletops, the recent studies analyzed in this review suggest a bifurcation in how these interfaces will evolve. On one hand, highly specific tangible applications are expected to persist, particularly those leveraging projection-augmented tangibility to seamlessly blend digital feedback with physical objects in domains like education and management (e.g., Clarinval *et al.* [2021]; Marlier *et al.* [2025]). On the other hand, the traditional standalone tabletop is likely to evolve into a component of broader, interconnected multi-device ecosystems or serve as a foundational interaction paradigm for immersive environments (e.g., Sikorski *et al.* [2020]; Ishihara and Rattanachinalai [2021]; Monteiro *et al.* [2023]). In this sense, the future of the tabletop may not lie in new physical hardware configurations, but in the virtualization of its collaborative essence.

It is important to highlight several methodological limitations of this SLR. The adoption of a strict protocol with well-defined inclusion and exclusion criteria, along with a pre-established search string, ensured focus and reproducibility but also restricted the sampling scope, potentially excluding studies that address tabletop hardware indirectly or under alternative terminologies. Similarly, we designed the extraction form to cover multiple technological dimensions, including display, input, and collaboration. However, it simplified some categories, particularly input detection. For example, it grouped techniques such as vision-based input, depth sensors, infrared tracking, and optical touch into a single category. This approach may have obscured relevant nuances among these techniques.

Additionally, while the Kitchenham guidelines suggest a formal Quality Assessment phase, we did not apply specific quality criteria to evaluate the empirical methodology of the primary studies. Because our objective was to map objective technological characteristics, the strict application of our inclusion and exclusion criteria, particularly EC1, was deemed sufficient to ensure the relevance and technical completeness of the selected works.

Furthermore, restricting the language inclusion criteria to English-only publications was a deliberate methodological choice to maintain a standardized global overview and prevent geographic bias. However, we acknowledge that this may overlook localized hardware adaptations or specific educational deployments. Future reviews could build upon this global baseline by conducting localized mappings focusing on specific languages or regional databases, to contrast how digital tabletop technologies were adopted and adapted in different regions.

Finally, although the search did not impose explicit date restrictions, all included and excluded articles span the period between 2001 and 2025. This range reflects the consolidation of terminology in the field following the emergence of platforms such as DiamondTouch [Dietz and Leigh, 2001], which established a more standardized nomenclature. As a result, earlier relevant works may not have been captured by the search, although their historical context is acknowledged and referenced throughout the study.

6 Conclusion

Based on the analysis of 556 articles selected through a rigorous protocol, this study identified historical trends in the development of digital tabletop systems. The data highlight the persistent prevalence of custom-made platforms throughout the field, alongside the limited adoption of standardized commercial solutions. Future reviews could expand on these findings by cross-analyzing hardware evolution with shifts in interaction design paradigms and collaborative practices.

The results also reveal a marked decline in publications on digital tabletops after 2015. This trend may reflect challenges such as high costs, technical complexity, ergonomic limitations, and the lack of standardization—issues previously highlighted in the literature—or a partial shift of research focus toward other forms of collaborative interaction, including immersive environments (VR/AR).

Future causal analyses should cross-reference this publication decline with external factors, such as funding trends and industry adoption tendencies, as well as conduct citation analyses to verify if the post-2015 drop correlates with a decrease in the overall influence of tabletop literature. Comparative studies between traditional tabletop interfaces and emerging platforms, such as immersive systems accessible via commercial headsets, may help uncover conceptual continuities and determine whether these new technologies can be considered a "spiritual successor" to digital tabletops.

Our research group intends to use the hardware and interaction mappings derived from this review as a foundation to develop cross-platform architectures. Specifically, we aim to explore how traditional tabletop applications can be ported to virtual tabletops in Augmented Reality, preserving their collaborative essence while overcoming the physical hardware limitations mapped in this study.

Declarations

Authors' Contributions

Gustavo de Freitas: Conceptualization, Methodology, Formal analysis, Investigation, Writing - original draft. Cesar Pozzer: Validation, Writing - review & editing. Lisandra Fontoura: Supervision, Validation, Writing - review & editing. All authors read and approved the final manuscript.

Competing interests

The authors declare that they have no competing interests.

Availability of data and materials

The datasets analysed and scripts used during the current study are publicly available online[12]. The repository contains the extracted data tables as well as the source code used for data processing and chart generation.

Further relevant information

Ethical issues. This study is a Systematic Literature Review based exclusively on previously published scientific articles and publicly available bibliographic metadata. It did not involve human participants, sensitive data collection, interviews, user studies, or experimental interventions. Therefore, ethics committee approval was not applicable.

[12]`https://github.com/Guglis02/Tabletop-Data-Extraction`. Accessed on 27 June 2026.

Use of generative AI. Generative AI tools were used in two specific stages of this study: (1) to assist in translating and refining the manuscript into English, which is not the authors' native language, and (2) as a programming assistant to write the source code for the data visualization charts. The authors reviewed, edited, and validated all AI-assisted content, conducted all data extraction and analysis manually, and take full responsibility for the accuracy, integrity, and originality of the final text and figures.

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