ISCTE IUL
REPOSITÓRIO
INSTITUTO UNIVERSITÁRIO DE LISBOA

Repositório ISCTE-IUL

Deposited in *Repositório ISCTE-IUL*:
2025-06-09

Deposited version:
Accepted Version

Peer-review status of attached file:
Peer-reviewed

Citation for published item:
Silva, N., Santana, P. & Mariano, P. (2024). A multimedia character-centric approach for history educational purposes. In Anabela Marto, José Creissac Campos (Ed.), Proceedings of the International Conference on Graphics and Interaction (ICGI). Vila Real, Portugal: IEEE.

Further information on publisher's website:
10.1109/ICGI64003.2024.10923762

Publisher's copyright statement:
This is the peer reviewed version of the following article: Silva, N., Santana, P. & Mariano, P. (2024). A multimedia character-centric approach for history educational purposes. In Anabela Marto, José Creissac Campos (Ed.), Proceedings of the International Conference on Graphics and Interaction (ICGI). Vila Real, Portugal: IEEE., which has been published in final form at https://dx.doi.org/10.1109/ICGI64003.2024.10923762. This article may be used for non-commercial purposes in accordance with the Publisher's Terms and Conditions for self-archiving.

Use policy

Creative Commons CC BY 4.0
The full-text may be used and/or reproduced, and given to third parties in any format or medium, without prior permission or charge, for personal research or study, educational, or not-for-profit purposes provided that:

- a full bibliographic reference is made to the original source
- a link is made to the metadata record in the Repository
- the full-text is not changed in any way

The full-text must not be sold in any format or medium without the formal permission of the copyright holders.

Serviços de Informação e Documentação, Instituto Universitário de Lisboa (ISCTE-IUL)
Av. das Forças Armadas, Edifício II, 1649-026 Lisboa Portugal
Phone: +(351) 217 903 024 | e-mail: administrador.repositorio@iscte-iul.pt
https://repositorio.iscte-iul.pt

A multimedia character-centric approach for history educational purposes

Nuno Silva*, Pedro Mariano*†, Pedro Santana*†
*Instituto Universitário de Lisboa (ISCTE-IUL), Lisboa, Portugal
†Information Sciences and Technologies and Architecture Research Center (ISTAR-IUL), Lisboa, Portugal
Emails: nfrms@iscte-iul.pt, plsmo@iscte-iul.pt, pedro.santana@iscte-iul.pt

***Abstract*—A historical narrative can be presented in various ways. This paper presents a multimedia-based educational mobile tool based on character-centered content presentation, with geographical points serving as the backdrop within a specific geographical and temporal context. This approach encompasses multiple fields of study, such as history and geography, introducing a computational model that explores the history of slavery. The key feature of this model is to create dynamic pathways that immerse the user in a multimedia storyline, supported by information technologies, including educational content and GPS data, among others. Usability tests were conducted on the developed mobile tool with a group of 10 participants, with promising results.**

***Index Terms*—geolocalization, multimedia, character-centered narrative, education, history, historical narrative, slavery.**

I. Introduction

This paper presents a multimedia mobile tool for educational or touristic purposes. The tool uses GPS with a model of classes and data, aiming to store educational content and develop pedestrian circuits. This content is anchored to various location points, which may be interconnected or independent.

Various historical episodes can share a common geographical point, transforming the location into a stage where different characters perform. The goal is to immerse the user in the described episode, providing significant learning about the culture associated with a specific place. This can be achieved through guided tours of historical and cultural points of interest. Furthermore, access to the content is not restricted to physical presence at the presented location, allowing anyone to access the provided information.

To validate this mobile tool, the chosen theme was the history of slavery in Portugal. It is crucial to emphasize that creating credible content on historical events or periods requires a focus on the lives of the protagonists and relevant geographical locations. Consequently, it was necessary to conduct a survey of historical sites and the biographies of key figures. To enhance the educational content related to the chosen theme, several pertinent academic works in the field of slavery in Portugal were utilized [4] [11].

The use of digital applications to convey historical narratives of a city is not a recent concept, even when the subject involves slavery. There are several academic works that cover this issue. One example is the study by Rodrigues [16], which offers an analysis of the black and enslaved presence in the city of Setúbal, aiming to "reveal a previously invisible past" [1]. The digital solution invites users to explore the city, highlighting the influence of the black presence in the history of Setúbal.

Another significant work is that of Murta [15], which adopts a multimedia approach based on the collection of historical content and personal testimonies from former residents of the city of Coimbra. The aim of this research is to recover the memory of the Alto da Cidade in Coimbra. The developed application utilizes augmented reality (AR) and GPS to superimpose historical images onto the contemporary landscape captured by a smartphone's camera.

In 2018, the New Orleans Slave Trade Marker and App Project was launched with the aim of educating visitors about the history of slavery in New Orleans. Howard analyzes the application within the context of tourism, emphasizing how it addresses the memory of slavery in the United States [12]. Through AR, the project displays sculptures by Marcus Brown and audio content that describes events at locations where enslaved individuals were sold, demonstrating to visitors how the city was built through the labor and trade of enslaved people [5].

The digital solution presented in this article continues the objective outlined in previous academic studies, while proposing an alternative approach. In the following sections, a scalable solution will be presented, initially designed for smartphones, aimed at highlighting not only the most relevant tourist attractions in the city of Lisbon, but also recalling the historical figures who were enslaved. The feasibility of this approach to slavery is due to the fact that the records of some enslaved individuals have resisted the passage of time. Thus, it becomes possible to develop a multimedia approach that rescues these figures from oblivion [4] [11].

The proposed application is not limited to a historical period or geographical location. As long as there are protagonists and evidence confirming their presence in certain locations, it becomes feasible to narrate historical events centered on these individuals, connecting various geographical points.

The proposed system allows for the creation of circuits based on tourist sites, which can be consulted or visited independently. This approach offers comprehensive perspective, in line with previous works, giving the user the option to visit the physical locations or not.

This work was partially supported by Fundação para a Ciência e Tecnologia (FCT) / Ministério da Ciência, Tecnologia e Ensino Superior (MCTES) under ISTAR projects UIDB/04466/2020 and UIDP/04466/2020

To ensure the implementation of this solution, two Application Programming Interfaces (APIs) and a scalable data model were integrated, which can be hosted in distinct geographical locations, provided that asynchronous communication with the application, hereafter referred to as 'app', is maintained. The architecture utilized follows the principle of separation of responsibilities, ensuring optimized performance.

This papper is organized as follows. Section II presents the system composition and addresses various technical aspects such as the class diagram and the developed data model. This section also showcases the visual output and some of the functionalities already implemented in the APP. Section III presents the results of the usability tests conducted with the target audience, and finally, Section IV presents the conclusions and the future work planned for this project.

II. Proposed System

A. System Architecture

In the example presented in Fig. 1, the functionalities available in the initial phase of this project are demonstrated. Users can select circuits, characters, or tourist points. Upon selecting the content, with the exception of tourist points, a map displaying the route of the chosen character or circuit is presented. All content allows navigation to the specific historical location, while providing access to various digital materials. Additionally, it is possible to organize the content in several ways: alphabetically (Name), by proximity to the user's geographical position (Proximity), by the estimated duration of the route (Duration), or according to the user's selected favorites (Favorites).

To develop this digital ecosystem, several IT tools were required, thus enabling the scalability and independence of the components that will be described throughout this article. Additionally, several essential components for usability were implemented, ensuring a seamless experience for users in the presentation of the planned content.

Initially, a class diagram and a data model were developed to logically store and organize all the necessary information for a constantly growing system. An API was implemented, serving as the entry point and control mechanism for the available content. All these components contribute to the structuring of a comprehensive and scalable system capable of integrating diverse narratives.

The Google Maps API was integrated into the project, allowing the reception of coordinates and rendering of maps based on those coordinates. It displays the planned route with the possibility of redirection to the APP itself.

The APP component was developed using the Android Studio emulator, aiming to reflect the design implemented and tested in a non-functional prototype created in Figma, which incorporated various anticipated functionalities for the APP. This effort culminated in the satisfactory completion of the essential part of the project, emphasizing the importance of usability in the implementation.

This endeavor yielded a microservices architecture, bestowing several advantages including scalability, reliability, ease of maintenance, delineation of responsibilities, and streamlined implementation [3]. This architecture facilitates seamless system growth to meet evolving implementation needs and fosters seamless communication with diverse APIs [3], supporting various programming languages [7]. Requests are efficiently processed through network queries, delivering the requested content in the specified format [7].

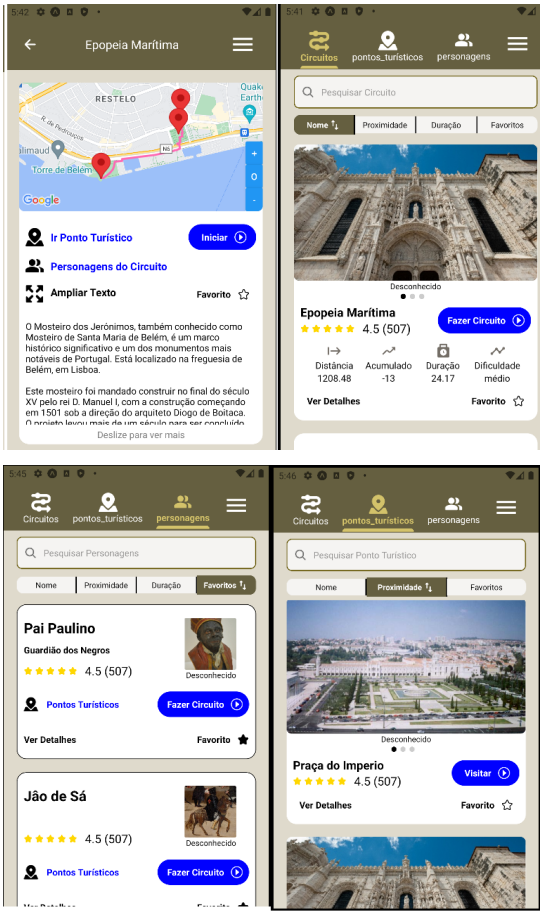


Fig. 1. APP Snapshots

B. Data Model

The purpose of developing a diagram is to logically organize all the information processed and presented by the API [9]. The resulting APP should render the classes presented in the diagram quickly and smoothly for the user, in addition to being scalable [9]. This means that the diagram presented in Fig 2 should be easily adaptable to theme changes and the inclusion of other types of content, such as serious games or optional questionnaires at the end of each circuit or visit.

One advantage of this approach is that it exempts users from providing personal data [2]. All content is publicly accessible, except for user ratings and favorite selections. This ensures universal access to information without the need to store personal data or require visits to specified locations.

The only private information consists of user favorites and ratings of available content, stored locally on the user's

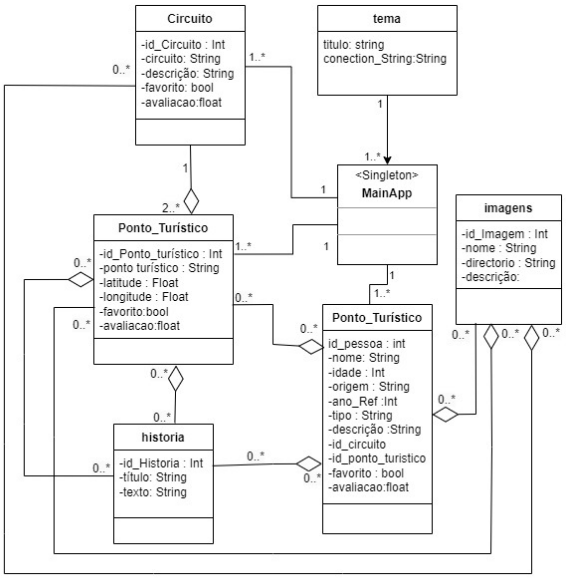


Fig. 2. Simplified class diagram due to space constraints.

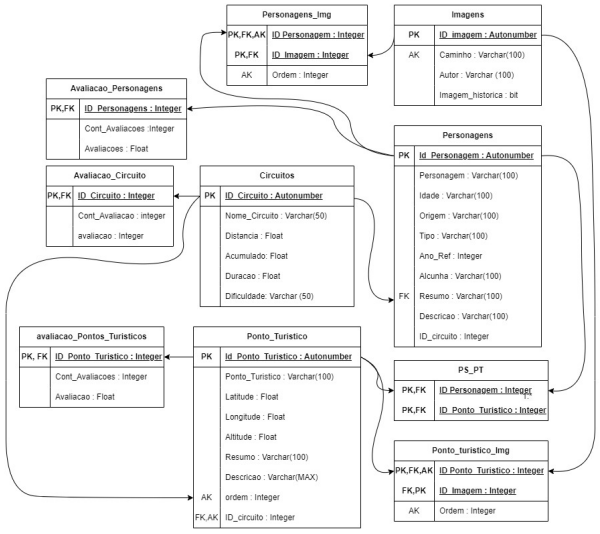


Fig. 3. Simplified data model due to space constraints.

device. This allows users to save preferred content, such as landmarks they plan to visit in the future. Users are expected to create personalized circuits based on their favorites. A similar strategy is anticipated to enhance the logging of evaluations.

The storage of user evaluations plays a critical role in maintaining content quality standards. This is the only information intended for storage in the database. Evaluations will also be stored locally, similar to favorites. However, users are expected to reevaluate content multiple times, with each new evaluation replacing the previous one in the database. Similarly, users cannot mark a landmark as a favorite more than once due to the boolean values assigned to content IDs, which are stored in the user's device memory.

C. Security Features

Data security and integrity are ensured by Microsoft SQL Server, which stores the content identifiers (IDs). The API verifies the IDs requested by the user through the APP and returns the requested content in JavaScript Object Notation (JSON) format. To ensure this information exchange happens securely, a specific user with limited privileges was created to view the database information. These data are manipulated through views [14]. The API accesses the database via this user, restricting modification, deletion, or addition operations to the database administrator only [14]. This ensures that APP users have exclusive access to secure data [14].

To ensure the dynamism and scalability of the project, a relational database model was developed, reflecting the class diagram shown in Fig 3. It was necessary to link the associative tables, which store the information that feeds the API responsible for presenting data to users, to the entity tables, in such a way that neither dynamism nor scalability were compromised.

D. Scalability and Multiplatforms

The decision to use React Native stems from its design as a framework aimed at developing cross-platform applications [17]. Together with JavaScript, a high-level programming language with a vast array of libraries, this choice enabled the development of both the API and the APP. The combination of these two tools, which share the same programming language, facilitated and accelerated the process of integration and communication between them. Additionally, coupled with a scalable data model, it allows for the creation of an asynchronous and scalable ecosystem.

The APP is responsible for rendering on the smartphone the information provided by the API in JSON format, regardless of the user's device. The API requests a significant amount of information from the database, which is made available via a URL in JSON format. The APP accesses this URL and renders the information as the user requests it, thus avoiding the need to store all the information in memory or make constant requests. On the other hand, the APP keeps the already rendered contents in memory, optimizing its performance.

The asynchronous nature of communication between the various components of the ecosystem reduces the dependence on a constant connection, contributing to reduced latency and providing a more agile and seamless user experience, particularly in unstable network conditions [6].

Employing the same approach, the API facilitates integration with other technologies and services, regardless of the user's device. This solution supports scalability to other platforms, such as the web, and enables integration with various APIs, such as Google Maps, making the system robust, scalable, and adaptable to a wide range of requirements [10].

E. Map Rendering

The integration of the Google Maps API into the project enabled the utilization of GPS resources offered by Google.

This brought several advantages, such as reduced development time, cross-platform compatibility, and global coverage that allows for the integration of maps and routes between geolocated points, resulting in a personalized user experience [8].

III. Preliminary Evalution

Initially, a non-functional prototype was developed using the Figma tool, incorporating several planned features of the APP for testing with a segment of the target audience. Nielsen's 10 heuristics [9] were applied to this prototype with the goal of identifying usability errors. After the correction of the initial errors or flaws, Nielsen's heuristics [13] were reapplied to ensure continuous improvement. Furthermore, the Cognitive Walkthrough method [13] was employed, based on the characteristics of the target audience, to identify and address any remaining usability issues.

After iterating the prototype in accordance with Nielsen's heuristics and the Cognitive Walkthrough method, the prototype was tested with a randomly selected group of 10 participants aged between 15 and 25. This test required participants to complete seven tasks using the tool, followed by a questionnaire. These tasks required users to perform three or four steps in order to achieve the desired outcome. For example, one of the questions was: 'Imagine you want to find a specific route (maritime epic); while reviewing this route, you need to discover who commissioned the construction of the Jerónimos Monastery. How would you accomplish this task?' In this case, the user was expected to locate the route, follow it halfway, and then backtrack two steps to analyze the information provided and discover the year in which the construction began. This question aimed to conduct formative and summative tests on the functionality of the buttons and the clarity of the presented content.

The responses were considered correct only if the user achieved the objective of the question. For instance, in the example above, even if the user found the information regarding who commissioned the construction of the Jerónimos Monastery through an alternative path, the response was considered correct. Otherwise, the response was deemed incorrect.

The results were promising, with most participants successfully completing the tasks associated with the seven questions. In Table 1, the first column lists the questions posed, and the second shows the number of individuals who were able to complete all the tasks for each question. The average number of correct answers was 9.6, with a standard deviation of 0.49.

TABLE I
NR. OF CORRECT ANSWERS

Question ID	number of people
1	9 in 10
2	9 in 10
3	10 in 10
4	10 in 10
5	10 in 10
6	10 in 10
7	9 in 10

At the end of the interview, participants were asked to provide a new assessment, rating the utility and usability of the mockup on a scale from 0 to 10. The results are presented in Table II. The same 10 individuals who completed the tasks mentioned above participated in this evaluation. Sixty percent rated the usability and utility of the tool as 9 out of 10. The average score was 8.6, with a standard deviation of 0.91.

TABLE II
USABILITY DISTRIBUTION OF FIGMA NON-FUNCTIONAL PROTOTYPE (ZERO-FREQUENCY ROWS REMOVED)

Assessments	number of users
7	2
8	1
9	6
10	1

Although some improvements, such as the removal of the login page, were identified, this remains a very small sample of users. Overall, in the summative tests, participants appreciated the app's usability and found it useful.

IV. Conclusions and future work

In this paper, we presented a multimedia-based educational mobile tool that focuses on character-centered content, with geographical points serving as a backdrop within a specific temporal and spatial context. This information system allows for the creation of various narratives. Additionally, we developed a mobile tool enabling users to visit points of interest and learn about historical figures.

The results of the tests conducted with 10 participants on the functional prototype indicate that it is feasible to develop a pedagogical and scalable tool designed to narrate multiple stories. This tool will enable users, in an educational context and supported by the various technologies discussed throughout this paper, to embark on a dynamic journey through the city, presented from the perspective of those who lived during a specific historical period.

Future developments include the incorporation of additional historical themes and the enhancement of the APP's security. The absence of user registration and the presence of a writing task (content evaluation) in the database may introduce vulnerabilities within the digital ecosystem. Planned improvements also encompass the addition of audiovisual content paired with AR, serious games or quiz related to the presented themes. For the case study, the history of slavery in Lisbon was used. However, for future work, it is possible to include other themes, such as the April 25th Revolution or the history of the fishermen of Nazaré. Furthermore, it is imperative to expand the population sample for usability testing. Although the tests conducted thus far have yielded promising results, it is necessary to broaden the age range of participants and increase the number of users to obtain a more comprehensive and accurate assessment of the tool's effectiveness.

REFERENCES

[1] ALCÂNTARA, A., ROLDÃO, C., AND CRUZ, C. Visita à setúbal negra (séc. xv-xviii): Desocultar a história local através da educação não-formal. *Visita à Setúbal negra (séc. XV-XVIII): desocultar a história local através da educação não-formal*, 2 (2019), 66–85.

[2] ALMEIDA, S. D. C. D. D., AND SOARES, T. A. Os impactos da lei geral de proteção de dados-lgpd no cenário digital. *Perspectivas em Ciência da Informação 27* (2022), 26–45.

[3] ALSHUQAYRAN, N., ALI, N., AND EVANS, R. A systematic mapping study in microservice architecture. In *2016 IEEE 9th international conference on service-oriented computing and applications (SOCA)* (2016), IEEE, pp. 44–51.

[4] CALDEIRA, A. M. *Escravos em Portugal: das origens ao século XIX: histórias de vida de homens, mulheres e crianças sob cativeiro*. esfera dos livros, 2017.

[5] CHAVEZ, R. New orleans was once the center of u.s. slave trade. this artist wants to make sure we don't forget, July 2022.

[6] CHEN, S., THADURI, U. R., AND BALLAMUDI, V. K. R. Front-end development in react: an overview. *Engineering International 7*, 2 (2019), 117–126.

[7] DAVE, C. V., PATEL, A., AND KESHRI, U. Microservices software architecture: A review. *Int J Res Appl Sci Eng Technol 9*, 11 (2021), 1494–1496.

[8] DOSHI, J., GORADIA, A., AND MISTRY, D. A review of google data visualization tools. *International Journal of Current Engineering and Technology 4*, 5 (2014), 3134–3138.

[9] DOURADO, M. A. D. Usability heuristics for mobile applications a systematic review. *Ain Shams Engineering Journal* (2018).

[10] EL-KASSAS, W. S., ABDULLAH, B. A., YOUSEF, A. H., AND WAHBA, A. M. Taxonomy of cross-platform mobile applications development approaches. *Ain Shams Engineering Journal 8*, 2 (2017), 163–190.

[11] HENRIQUES, I. D. C. *Roteiro histórico de uma Lisboa africana: séculos XV-XXI*. Edições Colibri, 2021.

[12] HOWARD, E. Slavery in the big easy: digital interventions in the tourist landscape of new orleans. In *Public Memory, Race, and Heritage Tourism of Early America*. Routledge, 2021, pp. 86–103.

[13] HUSSAIN, A., AND MKPOJIOGU, E. O. Usability evaluation techniques in mobile commerce applications: a systematic review. In *AIP Conference Proceedings* (2016), AIP Publishing.

[14] MOHAMED, A. K. Y. S., AUER, D., HOFER, D., AND KÜNG, J. A systematic literature review for authorization and access control: definitions, strategies and models. *International journal of web information systems 18*, 2/3 (2022), 156–180.

[15] MURTA, P. R. M. D. M. A cidade invisível-aplicação histórico-turística para dispositivos móveis sobre a antiga alta de coimbra. Master's thesis, Universidade de Coimbra, 2014.

[16] RODRIGUES, R. A. T. Setúbal negra-aplicativo para percurso urbano sobre a presença negra na cidade de setúbal. Master's thesis, Universidade de Coimbra, 2021.

[17] STANOJEVIĆ, J., ŠOŠEVIĆ, U., MINOVIĆ, M., AND MILOVANOVIĆ, M. An overview of modern cross-platform mobile development frameworks. In *Central European Conference on Information and Intelligent Systems* (2022), Faculty of Organization and Informatics Varazdin, pp. 489–497.