Cities exploration through overlapping of digital and physical world

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***Abstract*—As the digitalization of human knowledge progresses, an increasing number of different layers of digital information related to places situated in the real world is available, and it can be used to enhance the visiting experience of cities, not only for tourists but also for local citizens and any other sort of visitors. In a collaboration with Municipality of Pisa we are deploying an integrated system of city signage with special QR codes pointing to a software system called Signs that we developed with the goal of selecting the information layer suitable for a particular visitor. We are now improving this system with generative AI assistants capable of generating tailored content for specific visitor with dynamic support for multiple languages according to the used AI model capabilities. In this extended abstract we introduce the architecture of the system and outline its benefits.**

Keywords—QR, city signage, generative AI

I. INTRODUCTION

Enhancing visitors experience by providing information during the visit is common during visits of museums and other cultural heritage sites using devices like audio guides. The diffusion of smartphones and internet connectivity has progressively made possible to substitute organization' devices with personal devices accessing content available on Internet. Digital marks such as QR codes are widely used [1,2,3] to provide digital content contextual to a particular site, even though the immutability of these codes in city signage led to two main problems: contents are difficult to be maintained over the life span of a sign; and to adapt to visitors' interests. The need to address different types of visitors is often addressed by including multiple QR codes on the same sign delegating the visitor in selecting the most appropriate, whether for language selection or for kind of information. QR codes have been criticized as not widely available to users before 2020 pandemics, even though researchers discussed their usefulness in the tourism context [2]; pandemics helped to make popular QR codes to all and now their presence is pervasive and used for all sorts of services. The advantage of these codes is the low cost in print, close to zero, and it seems natural that every sign should include a QR code as an anchor between the physical and the digital world. Unfortunately, most projects tend to use QR codes to point to specific content and it is difficult to plan content for every printed sign in a city.

II. THE SIGNS SYSTEM

The *Signs* project is a software project aimed at decoupling the city signage from the digital content associated with each sign. In practice, every sign is associated with a unique ID and URL whose goal is to access to a Web system responsible for redirecting the visitor's browser to a specific digital content. Every QR code is indexed in the system database along with geographical information and we used the city flag to highlight a special role in the city information signage.

Figure 1. Example of QR printed in city signage.

A set of rules is used to determine the actual URL where the browser is redirected to by considering the contextual information such as location, time of the day, user identity (if available), previous scanned signs.

The *Signs* system is designed to preserve the printed signs over time by delegating the content to various web sites that may vary over time. The current signs available in the town point to a system which builds visiting routes using signs as guide points. We used a "metro" language to provide a metaphor easy to understand for visitors.

Figure 2. Example of metro line dedicated to Galileo spots in Pisa

It is possible to associate multiple digital contents to a single sign: in this case the system generates a dynamic card showing the different content planes allowing a visitor to switch among them. The UI is designed for mobile devices and the card is shown by tapping the bottom left corner of the page where the city logo is displayed as shown in figure.

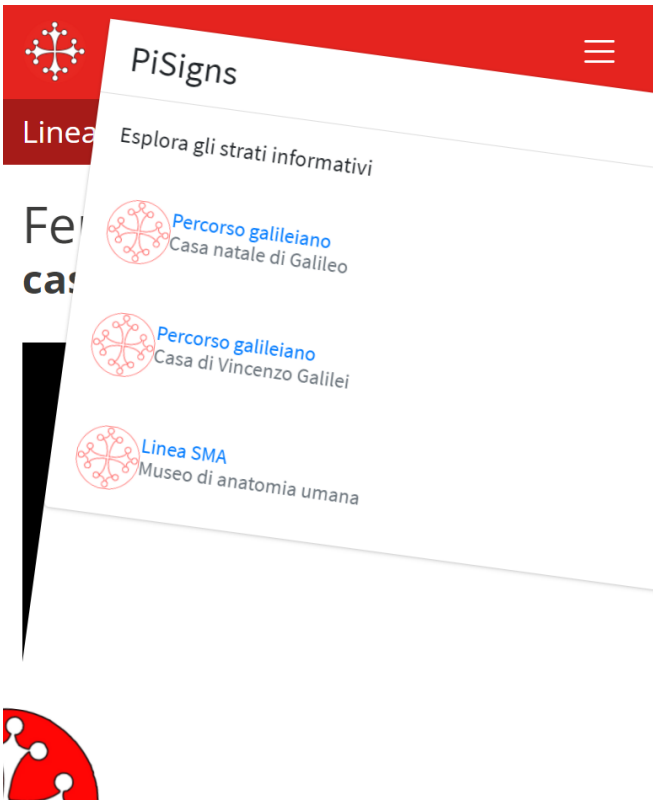

Figure 3. Example of the card showing multiple information planes associated with a sign.

Apart from ensuring a longer lifespan to QR codes printed on city signage and provide a more dynamic content targeting multiple types of visitors (i.e. in Pisa we have different populations such as students, citizens, and tourists), a common system of QR codes brokering the information offers a precious opportunity of monitoring visitors distribution across the town allowing for monitoring trends and support planning by the Pisa municipality.

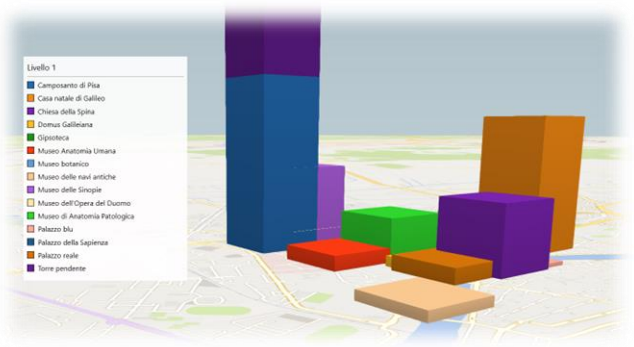

Figure 4. Analisys of QR scans in Pisa, the tallest bar is the Duomo site.

III. Generating content using Generative AI

We are now extending the Signs system by introducing generative AI assistants. For this purpose, we are using the Open-Source RAG framework Oraculum [4] to create dedicated assistants to provide multi-language information for each sign. Every Sibylla (the name of an assistant using a portion of the knowledge stored in the Oraculum knowledge base) uses knowledge expressed in *facts*, atoms of self-contained knowledge expressed in one language that an LLM model will use for generating the content tailored for the specific visitor.

The AI model is also used to provide suggestions about relevant facts related to a specific sign, including directions or dedicated descriptions given the specific path followed by a particular visitor, including the content that has already been delivered. The model can also be used to propose specific visits knowing the location of the signs according to user preferences and information about events that may be of interest for the visitor.

In Oraculum facts used to augment the prompt of the LLM can also be geographically localized and selected depending on the position of the visitor if shared with the system.

The introduction of generative AI technology is relevant not only for generating content in multiple languages having the information expressed in one language, but also because the level of detail of the narrative can be adapted to the visitor interests and knowledge. However, it should also be noted that a monitoring process of the quality of generated content should be set in place to ensure that possible model hallucinations and lack of information may lead to generate incorrect content.

Another aspect to be considered is to introduce generative AI based images content, though it should be evaluated the impact and the accuracy of the generated content. In the first iteration we will focus on text generation only with inclusion of traditional multimedia elements in the output.

IV. Conclusions

In this abstract we introduced the *Signs* system to create a pervasive city signage in which it is possible to include a QR code in each sign and later decide to which content it should point to according to the specific visitor need. Such infrastructure supports multiple information planes for single signs and allows for collecting data useful for city related planning. The inclusion of generative AI helps in creating a smart information broker capable of providing tailored content to visitors helping to provide rich and adaptive content not only related to touristic or cultural heritage elements, but also to more mundane subjects such as timetables, information about shops, etc.

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