IDEAIS: Smart Voice Assistants to Improve Interaction with SDIs

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INTRODUCTION

The initial moments after a natural disaster, such as an earthquake or volcanic eruption, are key to an appropriate and rapid reaction of decision makers and first aid respondents, such as civil protection, military forces, governmental agencies, among others [4]. In these situations, having in place an intelligent system/assistant that could help them access all the relevant information related to the disaster in a few seconds could definitely be a game-changer to radically improve disaster and emergency management situations. With this motivation in mind, we present the IDEAIS network, a research network composed of multiple Ibero-American partners to address this usability issue through the use of Intelligent Systems, in particular Smart Voice Assistants, to efficiently recover and access geographic information.

ABSTRACT

A critical goal, is that organizations and citizens can easily access the geographic information required for good governance. However, despite the costly efforts of governments to create and implement Spatial Data Infrastructures (SDIs), this goal is far from being achieved. This is partly due to the lack of usability of the geoportsals through which the geographic information is accessed. In this position paper, we present IDEAIS, a research network composed of multiple Ibero-American partners to address this usability issue through the use of Intelligent Systems, in particular Smart Voice Assistants, to efficiently recover and access geographic information.

1 INTRODUCTION

The initial moments after a natural disaster, such as an earthquake or volcanic eruption, are key to an appropriate and rapid reaction of decision makers and first aid respondents, such as civil protection, military forces, governmental agencies, among others [4]. In these situations, having in place an intelligent system/assistant that could help them access all the relevant information related to the disaster in a few seconds could definitely be a game-changer to radically improve disaster and emergency management situations. With this motivation in mind, we present the IDEAIS network, a collaboration project funded by the CYTED program (http://www.cyted.org, Ibero-American Program of Science and Technology for Development) from 2019 to 2022. Although IDEAIS is an Ibero-American network, it is open for international collaboration.

Behind this motivation, there is a need to improve access to geographic information that is necessary for good governance [11]. However, this goal is far from being achieved, despite the costly efforts of governments to develop Spatial Data Infrastructures (SDIs) [1]. This is partly due to the lack of usability of geoportsals and related geospatial services through which geographic information is accessed. Typically, decision makers near to the place of the event (i.e. mayors, local firefighters, local ambulances, etc.) are little or no experts at all in the use of SDIs (where the most complete geographic information is available), so it is essential to design an usable system to deliver the geographic information layers needed for each type of event. In the IDEAIS project, we propose the use of Intelligent Systems, paying close attention to recent technological developments related to the emergence of Intelligent Assistants to allow the development of Smart Voice Assistants for efficient recovery and access to geographic information.

Notwithstanding there is a significant improvement in voice assistants in various types of applications such as entertainment [7], laboratory assistants [2], and even in many daily life activities [9]; this kind of systems has been scarcely explored to access or manipulate geospatial resources accessible in SDIs. The above gives us a great opportunity to contribute in this area with the collaboration of this multidisciplinary research network.

As an illustrative example, consider a case in the context of civil protection: After the warning “The Tungurahua has erupted”, a Smart Voice Assistant would allow decision makers the following immediate actions: i) discover that the Tungurahua is a volcano and that the expression “has erupted” indicates a state of emergency; ii) identify the geographic regions that may be affected; iii) find in the corresponding SDI nodes the necessary layers of geographic information and cartography in case of an eruption; iv) interact with underlying servers and geospatial services for geospatial data processing and integration, if required; and v) receive and redirect immediately responses to stakeholders (i.e. the one who sent the alert, emergencies, police, firefighters, etc.) near the volcano.

 Although the technologies involved in this motivational example are to some extent in use in varied scenarios such as home automation and the development of Smart Cities [5], there are some specific challenges that must be faced to incorporate such technologies for intelligent assistants in conjunction with the current state of SDIs and geospatial services and tools in our scenario. In Section 2, we first describe the conceptual architecture of a prototype of Intelligent Assistant as motivated earlier. Based on such reference architecture, we identify in Section 3 the main research challenges for our network. Finally, we specify the next steps to achieve our objective in Section 4.

2 ARCHITECTURE

Figure 1 provides a reference architecture for the prototype. The Virtual Assistant component receives the user input and it uses the Natural Language Processing (NLP) component to process the input and determine the geographic information queries that are needed. For this task, the NLP component uses the Semantics and Ontologies component that models the disaster management domain, the
These layers have been used in the research network to divide the (GIR) package, and (iii) a Spatial Data Infrastructure (SDI) package (represented by the Catalog component in the architecture). The components of the architecture can be divided into three layers: (i) a Human-Computer Interaction (HCI) package, (ii) a Geographical Information Retrieval (GIR) package, and (iii) a Spatial Data Infrastructure (SDI) package. These layers have been used in the research network to divide the project tasks into workpackages.

**Figure 1: Proposed architecture**

### 3 RESEARCH CHALLENGES

In this section we identify and briefly describe the main research challenges to realize the Smart Voice Assistant and to achieve the objectives of our network.

- **Intelligent systems development.** The use of artificial intelligence techniques in geospatial data is a big challenge. In particular, the use of natural language processing methods to user communication or assistant, in natural language, to obtain information and interact with the SDI is a novel, current, and relevant research topic. These automatic question-answering (QA) assistants are becoming more popular in the research community and they have improved the voice interaction in very complex tasks [3]. Nevertheless, its implementation with spatial data has been very little applied. Specifically, the two main challenges in the generation of intelligent virtual assistants to interact with SDI are i) the design of intelligent algorithms using natural language with voice or even text; and ii) creating algorithms that are able to reason and act with as less human interaction as possible is a hard task to solve.

- **Communication between intelligent assistants and current standardization efforts regarding geographic information services.** Needless to say that Intelligent Assistants must still leverage them without reinventing the wheel.

- **Explore user experience challenges related with spatial data, information and knowledge required by decision makers in emergency management.** The characteristics of decision makers near the emergency, who may be little or no experts at all in the use of SDIs, require an evolution from the current approach of executing operations in SDIs to an approach driven by QA assistants. In addition, the study of legal guarantees and responsibilities in the use of geographic information is important in the emergency domain, in combination with the creation of a standardized knowledge base of terminology related to each type of event in natural disasters and emergencies. Finally, the International Standard Common Alerting Protocol (CAP) must be integrated, which also imposes some requirements regarding the user experience.

- **Design a scalable architecture and efficient components to retrieve all the necessary information within the strict time constraints of an state of emergency.** We will explore the use of a microservice-based architecture [8], which requires a rethinking of the current service-oriented architectures of SDIs and associated communication protocols. As this is an ambitious goal, a new hybrid architecture that combines classic services and microservices, designed for some specific and critical tasks, will provide a gradual transition. For the implementation of the new microservices we will study the use of efficient indexes that combine spatial, temporal and textual dimensions. Finally, mere access to the required information is not enough, because data from different providers must be interoperable to accomplish the goal. Interoperability poses different requirements either in attributes, geometry or both. We will research in particular the geometric problem, which is manifested for example by parcels that lie in the sea, Points of Interest that are compatible with Google Earth imagery but not with official cartography of roads, and so on. Not much has been done on the topic, but we plan to set up a Geometrical Conflation Comparison Exercise to address the issue [10].

### 4 OUTLOOK

By tackling the research challenges described above, IDEAIS network will contribute to advancing from traditional SDIs to next-generation Spatial Knowledge Infrastructures [6], in which the core element is knowledge instead of data or information. As we focus on rapid reaction after natural disasters, this is a crucial change to help decision makers who may not have the time or expertise to process and transform available information in SDIs to actionable knowledge.
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