ViTFlow: a platform to visualize tourists flows in a rich interactive map-based interface

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***Abstract*—In this paper, we describe ViTFlow, a platform to visualize tourists flows, integrating different data sources into a rich interactive map-based visualization. The data are collected using low-cost routers, enabling wi-fi passive tracking, and sensors, detecting environmental conditions, spread over the Madeira Islands. Different types of data can be visualized in the map-based interface, including spatio-temporal mobility data (i.e., movements between places and common paths taken by tourists), airplane and cruise ship traffic, weather information, and official events. We designed the interface with the aim of providing citizens and tourists with a public display to facilitate a dialog between the different communities, exploiting synergies to promote the sustainability of the archipelago.**

Keywords—spatio-temporal data, mobility, tourism, map-based interface, sustainability

I. INTRODUCTION

Island destinations represent a natural attraction for tourists, who often exceed the number of inhabitants, creating special challenges to sustainability [1, 2, 3]. That is the case of the Madeira islands, where, on the one hand, tourism has an important impact on the local economy (accounting for approximately 20% of the region's GDP), but on the other hand, it affects the sustainability of the archipelago.

An initial step to overcome this challenge is to understand the mobility patterns of tourists in the islands. That kind of information is gathered by the infrastructure developed in the BeanStalk project, exploiting a wi-fi tracking system and environmental conditions and air quality sensors, located in more than 60 points of interest in Madeira [4, 5].

Taking advantage of the APIs provided by BeanStalk, we designed and developed ViTFlow, a platform to visualize tourists flows, integrating different data sources into a rich interactive map-based visualization. The idea behind the system is to provide residents and tourists with a tool to stimulate reflections and dialog, with the aim to promote the suitability of the islands between the different communities.

II. THE SYSTEM

ViTFlow was built using Web Technologies, mainly HTML5, CSS3, JavaScript and SVG. The application is composed by different visualizations (layers) that enable users to interact with the diverse animations, each one originated from a data source and displayed in the map of the island. When a user requests a layer, ViTFlow has a Node.js application that establishes a connection with the Beanstalk APIs and returns the data requested to the client in a JSON format. Each visualization is integrated in the platform as a module that handles its own data processing and animation. Thanks to this structure, new visualizations can be created and added to the application, using a defined template.

To render the visualizations, ViTFlow uses the SVG transformation techniques, through the primitives provided by the D3.js framework [6]. This framework is also exploited to render the map, transforming the geographic coordinates of the geoJSON format into absolute positions on the screen.

A. Interaction

The navigation menu, on the top left corner of the interface (see Figure 1), allows to select multiple layers, from different macro categories. At the bottom, there is a navigation time graph, which displays historical data chronologically and allows the selection of an official event (red dots in the timeline of Figure 1), or a time window and a year. After selecting the visualizations and the time window, the system starts running an animation (at the selected speed), showing the data changes on the map chronologically. During the animation, the user can interact with the layer (by clicking and moving the cursor) to obtain more details.

In order to enable residents and tourists to interact with the animated visualizations using a public display, ViTFlow has been designed to support the menu navigation and the activation/deactivation of the layers by means of a gamepad, through the mapping of the functionalities into the gamepad buttons.

B. Available Data sources

Different data sources are explorable within the platform, each one including different layers, as described below.

Activity. It includes visualizations related to the mobility in the islands. With *Movements* it is possible to visualize how people move across the time between various points of interest, while *Common Paths* allows users to select a city and see the most common paths that start on that city.

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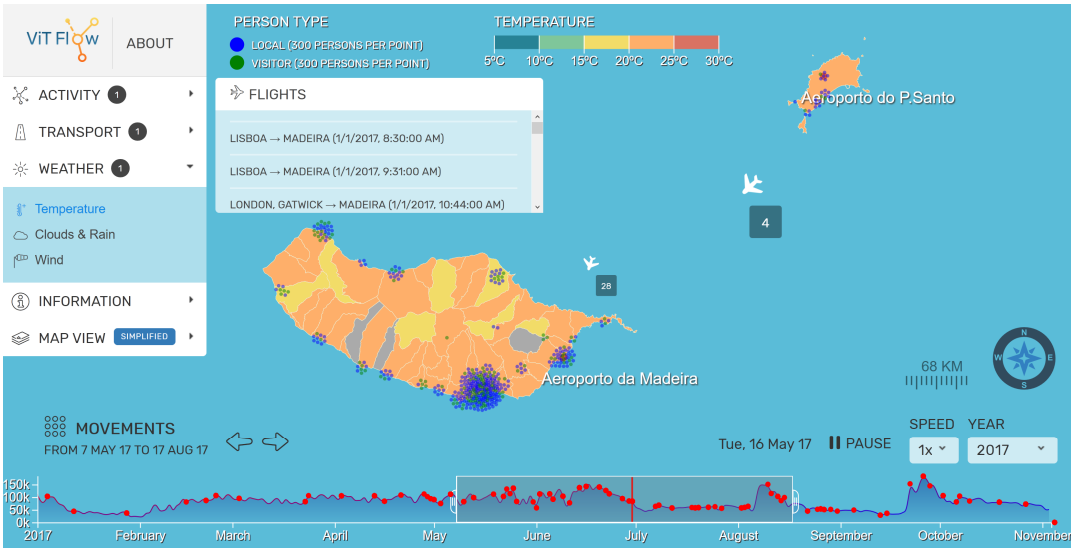

Fig. 1. Example of a visualization with the *Movements, Airplanes* and the *Temperature* interactive layers activated.

Each drawn path has a different color and its thickness depends on the estimated number of people who did that path. Instead, selecting the *Demography* layer, users can visualize pie charts placed on the different areas of the island, displaying the distribution of tourists and residents in that locations. The layer called *Tourists* shows a heat map with the distribution of tourists across the islands.

Transport. This category includes the visualization of the number of planes and/or cruise ships, and related information, that arrive in Madeira on a given day.

Weather. This layer displays information about five weather components. *Temperature* shows sub-regions colored according with an average temperature scale, while *Clouds & Rain* displays the percentage of cloudiness vs sunshine with translucid icons representing the prevalence of each one, and rain. Finally, with *Wind* it is possible to consult wind direction and speed (through the direction and size of the icons).

III. Preliminary Field Study Results and Discussion

To collect the users' reactions and feedback we performed a preliminary field study during the European Researchers' Night 2017, installing the public display in an informal environment close to a popular pedestrian street in Funchal. During the 3 hours session, 23 users approached our system (4 tourists and 19 residents). Participants (9 females and 14 males) ranged from 19 to 71 years of age. In average, each interaction lasted 13 minutes. Users approached the public interface in group (couples or groups of friends) and each visualization acts as a discussion tool, stimulating conversations and confirming the interests of residents and tourists in this kind of information and visualizations. In particular, tourists showed to be more interested in the *Weather* visualizations, while residents in the *Activity* layers (i.e., mobility patterns and demography). All the participants liked the *Transport* layers graphic, but the most of them found difficult to make sense to some represented information. Another interesting fact is that users liked to activate and mix different layers, looking for correlation in the represented data, such as number of events and flights in a specific period, and demography and weather in the different areas.

IV. Future Work

Based on the outcome of the primary field study, we plan to perform a new evaluation of the system, making it available in a public space for a continuous period of time, and tracking the user activities through the interface to obtain quantitative values to measure the users experience and the system performance. We also intend to integrate new data sources, such as public transportation routes and energy typologies and consumption, to facilitate communities in developing a more informed opinion on their sustainable/ecological footprint.

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