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Improving the Tourists' Experience

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Abstract. The Internet of Things (IoT) is part of a new paradigm where it is possible to integrate every sensor to the Internet, allowing it to be even more immersive and pervasive. Mastering these technologies, such as pervasive and smart places, is a challenge, especially when the goal is to achieve a closer interaction between citizens and applications. The rapid development and exciting innovation create an opportunity to stimulate a variety of new tools for tourists. Taking into account the versatility of IoT sensors for different applications, in this position paper we outline our perspective of ambient intelligence in smart tourism.

Keywords: BLE, Beacon, Mobile Device, Personalization, Ambient Intelligence, Internet of Things, Big Data, Tourism, Text Retrieval, Social Network.

1 Introduction

Today, people are surrounded by intelligent and intuitive interfaces embedded in all kinds of objects. It is a true challenge to design applications that support users of technology in complex and emergent organisational and work contexts [1]. Information and communication technologies (ICT) and all artefacts would fade into the background while people are immersed in a digital environment [2].

As stated by Cook et al. [2], Ambient Intelligence (AmI) is an emerging discipline that brings intelligence to our everyday environments and makes those environments sensitive to us. It is a multidisciplinary paradigm that draws a new kind of relationship between humans, their environment and the technology [3]. Friedewald et al. [4] state that it is a vision of the future information society stemming from the convergence of ubiquitous computing, ubiquitous communication and intelligent, user-friendly interfaces. Also, Aarts et al. [5] state that their ubiquity, transparency and intelligence will characterize ambient intelligence environments. In another way, Weiser [6] states that the computer of the 21st century should be invisible to its users. Also, it would be embedded in the environment. Such invisibility is related to the capacity of the technology to help users to reach their goals in a less obtrusive way. Others, such as Hopper

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[7], stated that applications could be made more responsive and useful by observing and reacting to the physical world and this is particularly attractive in a world of mobile devices and ubiquitous computers. The development of technologies including facial expression [8], emotion [9], speech [10], or gesture recognition, motion tracking [11], facilitate normal interactions with intelligent environments. Essentially, AML systems should know when it is convenient to interrupt a user when to make a suggestion but also when it is more convenient to refrain from making a suggestion [2].

Smart destinations enable a city to achieve a unique selling proposition and to make the overall experience of tourists visiting the destination more fun-filled and convenient [12].

As stated by Gubbi et al. [13], the evolution and convergence of several technologies, such as wireless communications, machine learning, real-time computer decision-making, sensors, cameras, and embedded computing are promoting the fast growth of the Internet of Things (IoT). Talari et al. [14] considered that these technologies, supported by a network of embedded sensors and applications, contribute to enhance the citizen's comfort and to simplify the work-life. In this context, concerning a close interaction between citizens and applications, explosive growth is expected in the number of the embedded sensor devices connected to the Internet in the next years. Around the world, the potential market of the IoT is expected to reach \$724.2 billion by 2023 [15].

The IoT is part of a new paradigm where it is possible to integrate every sensor to the Internet, allowing it to be even more immersive and pervasive. Most of the IoT sensors devices require significantly low-power consumption, given that these devices are expected to operate using a battery for months or years without resorting to external power sources.

In this position paper, we outline the emerging opportunity to use pervasive technology among other technologies to improve the tourist experience. Using BLE (Bluetooth Low Energy) as a new approach, we outline our approach for providing useful contextual services to the tourist in our scenario “Old part of the Town in Madeira Island”.

2 Background

2.1 Merging the ubiquity

The Internet of Things is part of a new paradigm where it is possible to integrate every sensor to the Internet, allowing it to be even more immersive and pervasive. Most of the IoT sensors are expected to operate using a battery for months or years without resorting to external power sources. To satisfy this expectation, suitable wireless sensor network technologies are required [16] including low power WPAN (Wireless Personal Area Network) standards such as Bluetooth Low Energy (BLE) [17].

BLE is a new approach to wireless communication with a large potential mainly due to its low power requirement and inexpensive characteristics compared with classic

Bluetooth [18]. These BLE small transmitters can act as beacons and are used to interact with mobile devices once they enter into their transmission range.

Using beacons, retailers can send customers notifications about product specifications, videos of how to use products, coupons, and deals. Retailers can also use the technology to monitor movements and patterns of customers within the store to improve product placements and personalise notifications based on past purchases [19]. Starwood Hotels & Resorts is running beacons in 30 of its hotels and resorts. The beacons are helping the concierges in greeting guests by name and accelerating the check-in process for frequent guests. It has also implemented a pilot program that will allow Starwood guests at two of their U.S. hotels to skip the check-in process and along with a partner application unlock their room door using their smartphones [19]. After being popularised by Apple and big brands, local businesses and institutions have also started using iBeacon technology to aid in their services.

In the famous Antwerp museum in Belgium, visitors are directed towards exhibits and notified about stories behind the exhibits. The beacons also stimulate interaction with visitors through interactive trivia questions [17].

2.2 Smart Tourism and Big Data

Smart tourism is a new buzzword applied to describe the increasing reliance of tourism destinations, their industries and their tourists on emerging forms of ICT that allow for massive amounts of data to be transformed into value propositions [20].

Smart tourism initiatives around the world are seeking to build viable smart tourism ecosystems [21] but the complexity of the sector makes it extremely difficult to go beyond the very specific platform, technology or service specific innovations.

Improving touristic experiences was in the scope of Human-Computer Interactions researchers in the past [22]. Poon [23] refers in his study the importance of technology as a strategic tool to tourism. Research on information technology and tourism has reflected the general understanding of how technology changes our society and economy [24]. There are now possibilities to access a variety of data, in massive quantities, in different formats and potentially real-time [24]. Fuchs et al. [25], presents a knowledge infrastructure which has recently been implemented as a genuine novelty at the leading Swedish mountain tourism destination by applying a business intelligence. Their study highlights how this type of approach can be used by tourism management to gain new knowledge about customer-based destination processes focused on pre - and post-travel phases. It is clear that big data can provide better, targeted, and profitable services and products to consumers [26]. For instance, big data analytics can capture information of consumer interest from social networks [27].

Ballagas et al. [28] designed a mobile game - REXplorer for tourists in Germany. The game uses locations sensing to create player encounters with historical figures that are associated with historical buildings in an urban setting. The game is designed to make learning history fun for young tourists and influence their path through the city. Others such as Schöning et al. [29] evaluated how information generated on-the-fly about a point of interest (POI) can be presented interactively using an augmented reality

approach. In another way, Marshall et al. [30] analyses how tangible multi-touch surfaces could be adapted to multi-user interactions between users in a touristic centre in the planning phase of a trip. More recent Zhang et al. [31] investigate how generating touristic trips differs when performed by a group of people, including inter-group communication, labour & information search division, and cultural difference between the tourists.

Potter et al. [32] explored the application of the virtual reality in tourism and found the great potential for the use of this technology in nature-based tourism for the provision of both information and education. Khan et al. [33] refer in their work that smart tourism has emerged over the past few years as a subset of the smart city concept, aiming to provide tourists with solutions that address specific travel related needs.

3 Proposed System for Passive Tracking

Main components are: beacons, offline tracking, Mobile App, Mobile tourist survey, count tourist, tourism big data, data analytics and a dashboard to show information.

Beacon locator and context information – Using new technology based on Bluetooth Low Energy (BLE) the beacons can be configured and implemented near each POI (Point of Interest).

Given the hyper-local and contextual capabilities of beacons, they are of immense value to both travellers as well as players in the tourism industry

Mobile device App captures the beacon signal, and context information can be sent to the mobile APP, and we take mobile device Bluetooth address and date/time (way of checking tourist present in that place). We implement a new approach to context information used in the commercial area applied to tourism business.

For example, tourists can be alerted about information on the PoI, transportation schedules, weather updates and public services in multiple languages, and at relevant times during the day.

Offline Tracking - tracking the actual behaviour of tourists in cities so that a set of possible routes that enlarge tourist options is taking into considerations for the identification of routes. This process runs in the developed APP, and it will record the location of the tourists periodically by GPS and store the information which can be synchronised when tourists reach a Wi-Fi point. A gamification approach could be added to increase tourist's attachment to their destination choice

Mobile Tourist survey – small survey to get tourist data, to collect demographic variables and other important data on their perceived visit to a place

Also in an installation phase, we will get personal information like age, gender, and numbers of days in the local.

Count tourist is a certain place. Can be performed by beacon interaction or by Wifi interaction of mobile device with Access Point, see work of Baeta et al. [34], where this strategy is applied to check the number of persons in public transportation. These mobility patterns can be collected passively without user intervention based on the probe request of mobile devices. These probes requests are sent periodically broadcasting

packets, which contain the unique MAC address of the client and (sometimes) the name of a network to which it had previously connected.

Tourism Big Data, a scalable Big Data management and analysis infrastructure were defined, implemented and set-up, according to the overall architectural design and the operational and functional requirements defined in the previous tasks. The resulting Big Data infrastructure provides a framework for dealing (processing and storing) data, with several characteristics as variety, volume, velocity and complexity, ingested in the system and provide the other toolkit components (data fusion and analytical modules) with the right capabilities to quickly and concurrently access and process

Data Analytics - Clustering algorithms like k-means, dbscan or heat maps identify patterns on users' movements. Data and time will be clusters and correlated with external events (holidays, festivals and weather information).

Dashboards present potentially disparate and complex pieces of information in a unified presentation view and are becoming commonplace. It is important for all stakeholders to understand the interrelated tourism dimensions and activities within a destination. We incorporate the most advanced techniques of data visualisation, especially for what concerns the ease of discrimination of the target of interest vs the rest of the picture.

4 Extracting Sentiments and Information from Social Networks

Social networks provide useful information about tourism because tourists express their opinions on it. For this reason, there is a real and concrete need to have an automatic and intelligent system to help to filter, prioritize and efficiently find the most relevant and meaningful type of situations that may inflict some type of relevant impact later on. The technological platform must also be built according to certain criteria, including ethical as well as technological and legal. The following approach of this tool was defined bearing all the above elements in mind to help experts in their tasks, as shown in Figure 1.

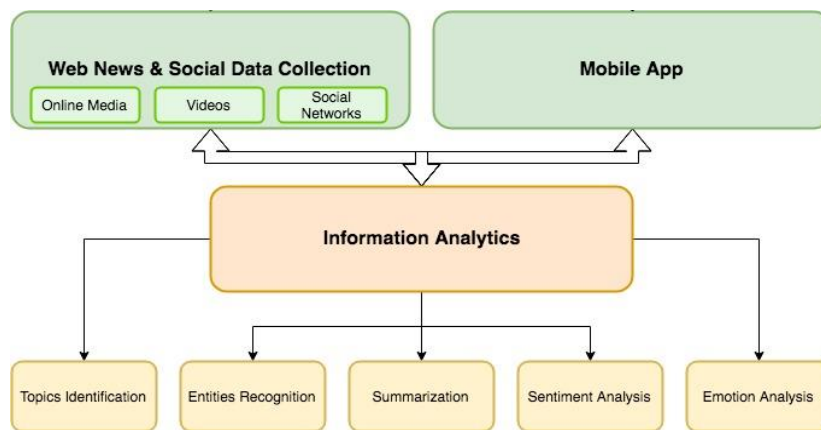


Fig. 1. Proposed Architecture to collect relevant information about tourism

Mobile App - A set of tools based on crowdsourcing mechanisms where a gamification platform is used to investigate user participation, provide relevant information, comments and interact with experts by answering pre-defined surveys. This method will improve the understanding of a particular situation/topic by listening specifically and directly the opinion of a group of people. Furthermore, in order to also expand the use of this application to as many people as possible (to create a significant statistical universe), these tools will also be using several gamification techniques, like rewards based on referrals to other users and complete answered surveys prizes.

Information Collection & Visualization - As such, we expect this interactive map of perceptions will be a measure to understand the role of perceptions and, together, a countermeasure to stop negative perceptions. It will be an instrument of cultural education, a media of creating new conscience inputs: users will be able to take a direct view of how social processes can be influenced by the formations of bad perceptions and, therefore, they can understand how important it is to have a sceptical and critical position on the veracity of some shared opinions. It will also be a methodological support.

Information Analytics – As such, and in particular for the case of online and web media like newspapers and magazines, it is necessary to process the documents to extract the relevant topics. Furthermore, a necessary step with document processing is the recognition of entities that can be useful when assessing risk situations and, in certain situations, the summarization of the all document (useful when processing a large news article for instance). As such, the following techniques will be applied as part of the data analytics set:

- **Named entity recognition** - An important aspect of text characterization, beyond the topics, are the entities that are referred in documents. In general, entity recognition consists in identifying entities and classifying them into one of the following classes: location, organization, person, date, time, money, product, etc. Common approaches to the problem make use of machine learning methods like Conditional Random Fields, Support Vector Machines and Neural Networks [35].
- **Summarization** - Summarization can be helpful by identifying the most important content of a larger information source. This can have a greater importance since documents (specifically larger documents) tend to address different topics. Also, it can be more difficult for a sentiment analysis tool to correctly assign a polarity to the whole document instead of a brief summary description, especially if different parts of the document exhibit different sentiment polarities. Therefore centrality-based summarization approaches [36] will be used to focus in identifying the main and most important topic of a document.

Additionally, with data coming from other sources, like social networks and surveys, the system will apply a set of specific analysis in order to first identify the sentiment

level (positive or negative) and second, to extract the emotions that may be associated with the given opinions (like enjoy, frustration, , etc.):

- **Sentiment Analysis** - The amount of information available in digital format, in the form of reviews, recommendations, ratings, or any other form of opinion, has been giving a prominent place to knowledge extraction tasks from of unstructured data, among which sentiment analysis stands out. When applied to data sources like tweets this task becomes a fundamental tool in several areas, allowing to perceive trends and opinions regarding a topic or an event. Sentiment Analysis can be done at different levels of complexity, where in its most basic form consists in assessing if a given document (or part of it) is positive or negative. However, the task may involve higher levels of complexity, such as identifying more than two types of sentiment or identifying the intensity associated with the sentiment. The most common approaches to sentiment analysis tasks include, on the one hand, the use of sentiment or polarity lexicons and, on the other hand, the use of machine learning methods. Semantically distributed representations of words can be used instead of the words themselves and, in general, lead to better results [37]. Recent approaches based on deep neural networks have been able to achieve performances never before achieved in many sentiment analysis tasks, especially those involving huge amounts of data.
- **Emotion Analysis** - An interesting type of information to extract from text in this context is emotion. Emotion extraction goes further than detecting sentiment polarity — positive or negative — and relies on a model of emotions like the one from Ekman and Friesen [38], which lists six different emotions: happiness, anger, disgust, fear, sadness, surprise. Approaches, in general, explore, on the one hand, different features, and, on the other hand, different classification methods (supervised, like Support Vector Machines, or unsupervised, like clustering or topic modelling approaches) [39]. This type of information can help to improve the characterization of the general opinion of the public. A common studied information source is microblogging, one of the defined information sources.

Finally, based on the information extracted from the all the mentioned components, the situations for each monitored topic are identified, scored and then ranked. As such, each situation or topic, depending on the data source, will have a risk impact probability and in the case of online news, a brief summary. This information will be shared with the experts to be used to better assess the overall risk probability of each topic.

5 Validation

We apply a small scale test in "Old part of the Town" in Madeira Island, (*see Figure 2*), using a passive Wi-Fi tracking system based on AP in each point (*A, B, C in the figure*) and a central tracking cloud server we can obtain the information of how many tourists we have in this location. We track user path and beacons on position A, B and C gives context information and identify tourism running the APP.

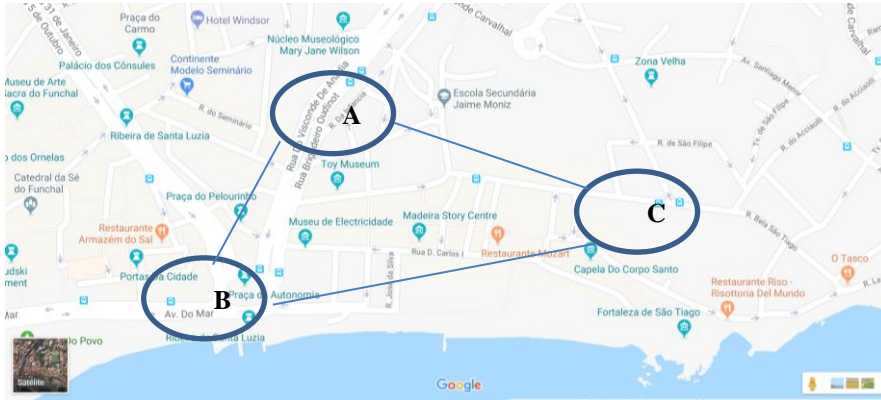


Fig. 2. Possible Path in the "Old part of the Town" in Madeira Island.

Using the Beacon technology is a solution that has aimed to provide location as context. With the power of beacons, tourists can also discover a host of experiences in the city - from easier city navigation to personalized city experiences that provide access to rich digital content on their mobile devices. Beacons with their ability to source customer data around physical locations, activities, time and personal interests, provide a huge window of opportunity to target the end users with personalized and contextual experiences to ensure efficiency in the use of the city services. Given the proliferation of mobile phones and other wearable gadgets and merging the ubiquity of these devices with beacon technology allows us to explore new opportunities in providing contextual services [40]. Providing contextual services for tourists using beacons and other information sources can be an alternative to improve the tourists' experience. These context-aware experiences through wireless interfaces using remote devices have become more common in our daily activities and are triggering technology and business shifts.

We also check behaviour in public transportation (buses) with tests performed during a week period in a series of buses. We chose buses with few passengers to facilitate the manual counting and the manual identification of each route path performed by each passenger. These requirements were made because we wanted to evaluate our current proposal with real metrics. It was possible to identify a number of tourists (persons with App on and signal caught by bus Wi-Fi) and check their path (stop in and stop out). Figure 3, shows the approach performed, where we show a small extract of data collected regarding GPS data and door sensor. The process started with data collection, cleaning and store in a SQL database. Data is available from the probe requests in AP, sensors door (open/close), timestamps and GPS, bus route schedule and route information. The second process step is the temporal and spatial correlation, where the output is hashed mobile device MAC address with information about the stop he gets in and out. The last process is the manipulation of this data towards the information (number of passengers and route path of passengers).

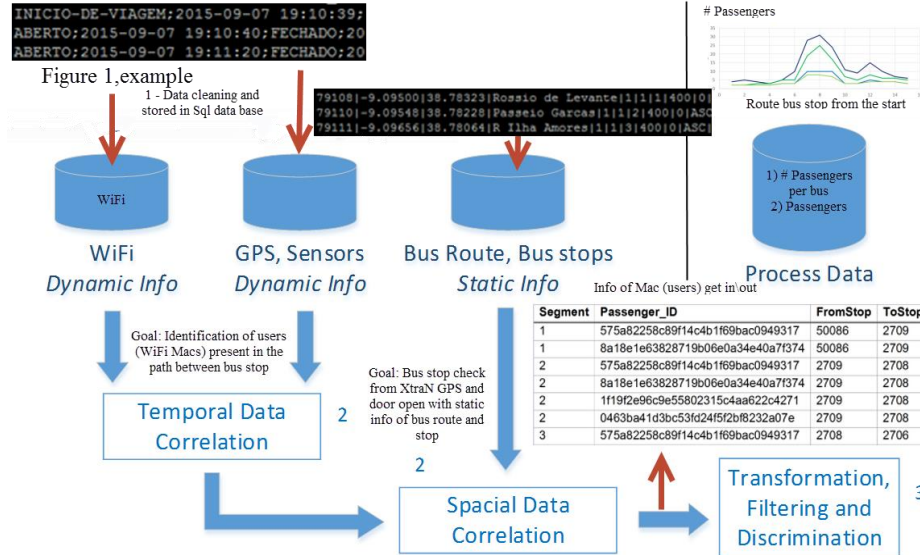


Fig. 3. – System developed to track tourists at buses.

6 Discussion and Conclusions

Interaction with technology gives fresh possibilities to use it creatively while also leading to the evolution and sometimes to a transformation of that specific technology. Emerging technologies can develop better and more creative solutions to the problems that we face in our day to day [41]. As Gross et al. [42] states, making computationally embedded things demands cross-disciplinary creativity. Ambient Intelligence is designed for real-world, physical environments, effective use of sensors is vital [2].

As stated previously, one possible scenario of usage could be described as, e.g., based on a mobile device with sensor information (accelerometer) it is possible to check people's attention in a specific location or point with mobile device key pressing detection. Also, as stated before, Wi-Fi probe requests or Bluetooth can be used to identify people present at a specific point.

This position paper was written with the intention to spark an initial discussion around ambient intelligence and tourism with the simple focus of how to design new solutions that involve user interactions.

New research could be conducted, especially providing ubiquitous solutions whereby these new technologies can enhance the tourist experience. For future work we can raise an interesting question facing the high-speed evolution of technologies that is: how can we develop solutions that can be part of future environments in smart tourism?

Also we give steps towards the creation of big data for tourism and the potential of data analytics to improve tourist offers and policy.

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