Tourism Guidance Tracking and Safety Platform

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Abstract. We propose a platform for tourism Guidance Tracking and Safety (GTS) based on beacons Bluetooth Low Energy (BLE), mobile device App and a central cloud server. Context information is provided to improve tourism transportation options taking into account local offer and a collaborative gamified approach is applied to share trips and advice natural trails walk. Guidance, safety is provided in remote natural walks and a case application in Madeira, island Levadas, natural trails. This work is the results of a submitted project between ICSTE-IUL and Madeira University used to create a tool to get tourism data, advice and orient tourism for ecological trails.

Keywords: Beacons, app, Mobile device, orientation

1 Introduction

Every tourism activity has specific geography and temporal sequence, and contemporary tourism geography is a growing field of study. Considering this reality, we propose the creation of a shared platform to collect tourist data in a non-intrusive way that provides context personalized and safety information based on the new approach of beacons interaction with mobile devices. The management of the collected data supports better policy taken decision as well as touristic operators' new offers to best meet tourist needs. Improving touristic experiences was in the scope of Human-Computer Interactions researchers in the past [1]. Poon [2] 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 [3]. There are now possibilities to access a variety of data, in massive quantities, in different formats and potentially real-time [3]. Fuchs et al. [4], 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.

The main goal is the acquisition of quality data to create new and improve tourist product offers while also supporting informed policy decisions and prepare better transportation offers. 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 [5]. Some authors stated [6], that 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). 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 [7] including low power WPAN (Wireless Personal Area Network) standards such as Bluetooth Low Energy (BLE) [8]. Schöning et al. [9] 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. [10] 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. [11] 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.

Based on IoT technologies, information on how tourists move can be acquired and complemented by other tourists' related data (e.g., range age, gender, country, visiting days, visited places and impressions) collected from social networks for additional information about their impressions about a place. Data is then processed to extract knowledge for Tourists Offices and local Operators.

A Mobile App shall be developed for tourism usage, giving integrated context information about the local region to help tourists decide/choose Point of Interests to visit and to know the best way to get there, and to receive safety advises and related recommendations.

2 Context

2.1 Madeira Tourism

Tourism potential on Madeira Island lays on natural resources available for the activity, in the exceptional laurel forest UNESCO World Heritage site [12]. A special interest on this ecological unit enforced building the highland waterway levadas. The circa 1400 km of manmade-infrastructures are constantly channelling water from the Northern part of the island, where is more humid because of the higher amount of precipitation, to the southern part of the island where the climate is drier in comparison. They supply water for agriculture and plantations of sugarcane and at later stage to vineyards to produce Madeira wine [13]. They play a very important role supplying water to the hydroelectric plants installed on the island. The levadas offer the possibility to walk through the laurel forest, a unique sightseeing in the world; they still an alternative way on land connecting villages and urban structures, often used for tourism activity. During the period between October and April is when most of the cruise ships disembark on Madeira, being a great contribution to tourist arrivals, but due to the reduced time on land, just few levadas are visited. Tourists booking a longer stay on Madeira Island and traveling by plane are the ones visiting more often the trails. Regardless of the importance of levadas sustaining local economy, there are few studies centred on their tourism potential. Authors like, Almeida, et al. [14] are studying their use for tourism and their contribution to the variety of offers. For three months, 150 tourists interested on walking routes registered their opinion on a tailor-made survey provided on the most visited trails on Madeira Island. Tourists gave value to this experience as an opportunity to have direct contact with nature, but not necessary engaging on physical activities. The region offers excellent natural resources for tourism activity, cultural assets and ages-old architecture; however, motivation to visit the Destination lays on enhancing their well-being through the unique island landscape, trekking on levadas and the climate. Although, there is a lack of studies centred on tourism on the levadas.

2.2 Tourism carrying capacity of natural tourist attractions

Tourist managers concerned with possible impacts from visitors' flow, use operational data for planning and managing of the attractions [15]. In Spain, García and Ventura [16] studied tourism and the public use of natural protected areas with the intention to assess impacts of visitors by using carrying capacity. In Mexico, some authors [17] used this methodology to determine tourism capacity on the mass tourism destination of Cozumel. They adjusted the methodology by creating local indicators for sustainability based on independent variables thought more feasible to quantify. In Portugal, [18]assessed tourist capacity to provide thresholds for beach management. Queiroz et al. [19]determined the tourism carrying capacity in the Azorean Islands using Cifuentes's correction factors for social, precipitation, light and accessibility, highlighting the social factor affecting greatly his calculation by considering groups of 15 people and a minimum group distance of 250m. Moreover, tourism capacity shall be taken as a borderline relating actions to minimizing impacts from tourist activity.

Despite of the methodology being commonly accepted, several concerns point out the subjectivity by using variables requesting permanent revision. Tourism capacity can be the visitors' perception linking rhetorical thresholds. As human values influence the calculation of such limit, it is very difficult to find the real threshold for visitation [20]. For example, local people being more familiar with a tourist attraction, register different satisfaction levels related to sense of crowding. Patterns for local and foreign visitors' variate greatly as behavioural attitude differs also [18].

However, the assessment of tourism carrying capacity provides a start point for managing tourism; it carries the ability to understand boundaries for visitation related to sustainability. The process itself is not extremely technical, which reduces the need for specialised people and costly equipment.

2.3 Beacons

A Beacon is a small Bluetooth Radio Transmitter that repeatedly broadcasts synchronous Bluetooth Low Energy (BLE) [21]signal in a restrict region/area. Each signal contains configurable data that can be received by a smart device. A beacon example can be observed in Figure 1 .

Fig. 1 - Estimote Proximity Beacon (left) and BlueCats AA Beacon (BC-313) (right).

Estimote Beacon It was implemented by Estimote, Inc - a company founded in 2012 by Jakub Krych and Łukasz Kostka, graduates from Jagiellonian University and AGH University of Science respectively. Nowadays, Estimote sells five types of products [22]: Location UWB Beacon, Location Beacon, Proximity Beacon, Sticker Beacon, and Video Beacon. The most appropriated Estimote product to use in an Indoor Location concept is the Proximity Beacon. This device holds an average of 2-3 years of battery life and a configurable range of maximum 70 meters in open field.

BlueCats Beacon In 2011, BlueCats was founded by Cody Singleton, Kurt Nehrenz and Nathan Dunn in USA and Australia. Indoor location devices are the core of this company. There are 3 types of beacons available on the marked: AA Beacon(BC-313) [23], Coin Beacon [24] and USB Beacon [25]. The most designated BlueCats product for complement this project is the AA Beacon (BC-313). This indoor location device holds waterproof and a battery life of maximum 5 years depending on the device performance.

Beacons are the most recent indoor location technology, it is easy to configure and to maintain. It has its own API for the developers that want to implement an ILS. The security and Privacy of the users are safe, and the cost of each equipment is not expensive. Both beacon types, Estimote and BlueCats, have very similar characteristics so we are sure that both would fulfill all the requirements of this project. Since the price and the characteristics of both beacons are similar, we chose the Estimote beacon because the design of the product holds a better look. Figure 2 and Figure 3 shows the design of both products, Estimote Proximity Beacon and BlueCats AA Beacon (BC-313).

3 Architecture of GTS

Taking into account our research goals our platform are based on: GPS tracking in a mobile App, an App that performs user interaction, Central cloud server to store data and perform data analytics with a dashboard, beacon configurator.

GPS Tracking – module to track tourists in cities so that patterns of movement can be recognized and preferred routes identified. This process runs in the 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 apps.

Beacon locater and context information - Using new technology based on Bluetooth Low Energy 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. The beacon signal will the captured by mobile device App, and context information can be sent to the mobile APP, and we take mobile device Bluetooth address and date/time (way of checking the tourists present in a specific place). We aim at implementing a new approach to context information used in the commercial area applied to the tourism business. For example, tourists can be alerted about useful information when they are close to a PoI, transportation schedules, weather updates and public services in multiple languages, and at relevant times during the day.

Cloud Server and dashboard - A cloud platform will store data and run all developed process for data analyses. All developed will be available and since it is a cloud environment can be shared. During the project, we will discuss with each Tourism Office existing local server and how local information can be stored.

We incorporate the most advanced techniques of data visualization, especially for what concerns the ease of discrimination of the target of interest vs the rest of the picture. To achieve this, a Dashboard will be developed. Dashboards present potentially disparate and complex pieces of information in a unified presentation view and are becoming common place.

4 Context Information and Beacons

These BLE devices are responsible for sending data that is going to be after received by the End User smartphone (as a BLE signals receptor) that is going to be after converted as user current location by the app. To validate the source of each BLE signal, each beacon needs to be configured and placed separately by System and Database Administrators in order to distinguish each beacon separately. As long as the End User smartphone receives a different BLE signal when walking through, the user current location is updated.

Beacon Physical Placement

The role of this process is to get the number of beacons needed, the position where each one is going to be placed in each building and the broadcasting power in order to get a good performance of the ILS, avoiding BLE signals overlap. If there is BLE signals overlap the correct user location can't be assured. An external mobile App was developed to test the beacons, named NearestBeacons App. The first step is the Beacon Manager. This entity is responsible, as the name says, to manage the beacons that the smartphone can intersects while the user is walking. Estimote provides an SDK that offers an API to handle the BLE connection, so there's no need to monetize and process all the packets that are nearby the smartphone because this API fulfils the requirements of what is needed in this entity. To import this SDK, we need to add it as a dependency of the Android Studio project. In Gradle Scripts, into the build.gradle, we just need to add the dependency. Until now, version 1.4.0 is the most viable to use, so that is the one that we choose to work. The second step is the BLE signal parametrization.

Broadcasting Power and Range

Broadcasting Power is the power with which beacon broadcasts its signal. The range is described as the area where the BLE signal can be intersected/received by other smart devices. Broadcasting Power directly impacts the signal range. High power values mean that the range is going to be bigger/longer. The Broadcasting Power can be set from -40 dBm (minimum) to +4 dBm (maximum) – corresponding to a minimum range of 2 meters and maximum range is 70 meters, without obstacles between the Beacon and the receiver.

Advertising Interval

The beacon's transmission packets can be configured in a restrict interval, this interval is the time when the beacon is "sleeping", which means how long the beacon will be freeze until sending another Ibeacon packet. For example, if the interval configured is 100ms, it means that the beacon will broadcast its signal once every 100ms (or 10 times per second). It can be set from 100 ms to 2000 ms. Choosing the interval can affect the battery life of the equipment: when the interval is low, more packets are sent, which means that the battery life will be shorter.

Beacon Identification Parametrization (using the IBeacon Protocol)

The IBeacon protocol [26] was developed by Apple in 2014. This protocol enables the configure which data, and its format that is going to be sent in BLE signals of the beacon.

In each IBeacon packet there are the following features:

- UUID: 16 bytes, usually represented as a string, e.g., "B9407F30-F5F8-466EAFF9-25556B57FE6D";
- Major number: 2 bytes, or an "unsigned short", i.e., a number from 1 to 65,535;
- Minor number: 2 bytes, same as Major.

This data format offers the user/developer the ability to create a hierarchy of beacons and lets the app get the information it is inside or outside the Beacon Region. This protocol is suitable for this project because in each BLE packet three fields are sent so it is possible to have more combinations and be more specific when identifying the beacons signal origin.

BLE Signal Characteristics

The Received Signal Strength Indicator (RSSI), is the strength of beacon's signal as received on the smart device. This is related to distance and Broadcast Power, i.e., the strength depends on distance and broadcasting power values. Considering the maximum Broadcasting Power, +4 dBm, the Received Signal Strength Indicator range from approximately -26 (close distance, few meters) to -100 (40-50 meters). The RSSI can be used to estimate the distance between the device and the beacon.

NearestBeacons App

A mobile app called NearestBeacons was developed by the author based on the Estimote API [27]. This auxiliary application has the objective of evaluating the BLE signal, depending on the position of the user, as a monitor of BLE signals intersected. This app, when scanning and detecting one or more BLE signals, print the following fields of each signal order by signal strength (RSSI) on the smartphone screen:

- Major and Minor: to identify which beacon we are evaluating;
- Measured Power: "indicates what's the expected RSSI at a distance of 1 meter to the beacon." [28].
- RSSI: Signal strength value that depends on distance and broadcasting power [29].

The string format that is printed on the screen, for each intersected BLE signal, follows the next nomenclature: [incremental intersected BLE signal counter value] + " – Major:" + [Major value] + "|Minor:" + [Minor value] + "|MeasuredPower:" + [Measured Power value] + "dbm" + " |Rssi:" + [RSSI value] + "**". Figure 2 shows an example of NearestBeacons app showing two intersected beacons ordered by RSSI value, with the corresponding fields referred above.

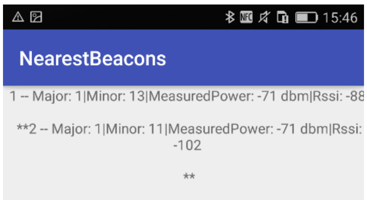

Fig. 2. - NearestBeacons scan values example

5 Levadas App

Trail map and all related information are loaded in our App storage. GPS gives position and related information is represented based on users position. If GPS is not available beacon can generated alerts information. For example dangerous zones, guidance when alternative paths were available. This still a conceptual work that we intend to implement under TABS project (Interreg Atlantic submitted project). Previous load information in the app can give details about the places. Major output is the alerts in dangers places, where we allocate beacons. When mobile device is in the range (we configure 70 meters), the mobile app is awaked by beacon signal and information is displayed about the problem. We validate the concept at our university in an indoor guidance system [30]. Tested in a population of the system around 100 walks were measured an evaluated system location and information. Indoor location with BIM information gives a good location.

Testing @Iscte Campus - Due to delays on project we prove concept at our university campus and wait for this installation. We use a set of 26 Estimote beacons. Test Cases To perform these tests, we needed to choose where would be the current position/location of the user in Edificio 1 and also pick the final destination. But before that, we decided to split these tests into two approaches: the current location floor is the same of the destination and the other one, the current location floor is different from the destination floor. Also, in the end we tested the situation of running the mobile App in a position that is not covered by a beacon region.

The current location floor is the same as the destination In this test, the current location floor is the same as the destination floor so there is no need to use stairs or elevator, so we expected that the App only renders one map floor. The user is going to choose the room 1E02 as a destination, and his current location is going to be on the west side of the floor on the left bottom. Each location can be confirmed in Figure 3 (left), the current location in yellow and destination in red color. Having this current location and destination on the same floor, the Find Me! App can calculate two possible paths to reach the destination. One is through the south corridor and the other through the east corridor. Figure 3 (right) represents the two expected possible path.

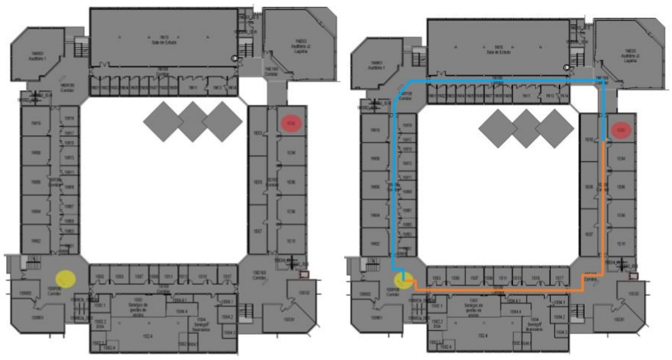

Fig. 3. - Floor 1 map with current (yellow) and destination (red) locations marked (left) and - Floor 1 with paths possible options marked (right)

6 Conclusions

This beacon solution with pre-loaded information can play an important role in natural trails where there is no cellular network, giving guidance and safety alarms. The app can track also tourists to better understand their behaviour. In spite off not being installed in a natural trail, the solution has more than one-year working experience in indoor guidance environment and also for emergency evacuations. With a very easy installation process, the current solution is limited by beacon battery duration each is also related to beacon range, but at local university tests, we are running the same beacon for more than two years. This solution can be applied also in a point of interesting to track tourists and give them useful information about the place.

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