“In search of Light”: Enhancing Touristic Recommender Services with Local Weather Data

Abstract
Many destinations’ economies strongly rely on tourism. To entice tourists to return to a destination, it is crucial to meet their expectations. The geographical formation of certain touristic islands often leads to local climates where it can be rainy and windy on one side while sunny on the other. In this paper, we present LightBeam, a mobile location-based application aiming to improve tourists’ experiences. The application focuses on providing real-time guidance for tourists seeking sunlight to maximize their holiday experience. The app’s main goal is to suggest the closest points of interest (POIs) to the user with the "best sunlight". To achieve this, we implemented and installed a network of geospatial sensors. The data collected from there is combined with the current location of the users to provide recommendations. We report on the initial design and prototype of LightBeam.

Author Keywords
Weather application; Mobile Application; Tourism; User experience

ACM Classification Keywords
Algorithms, Experimentation, Human Factors, Measurement
**Introduction & Motivation**

New and in particular mobile technologies have revolutionized the traditional model for tourism by allowing easy access to a variety of information about tourism destinations. Still, many travel decisions are made based upon weather conditions and a “search for the sun” [8][10]. Many tourist destinations are well known for their good weather all year round. In destinations with microclimates however, weather often can be unpredictable [20] (e.g. it might be heavily raining in one location while another is sunny). Bad weather is considered to be an important factor for negatively effecting a holiday experience. Imagine a tourist in search of the sun; a lack of sunlight can ruin their holiday experience as seen in the work of Maddison [8].

Currently, most tourist applications simply inform of activities to embark on or deliver weather information based on forecasts. Tourists must research for activities they’re interested in or POI they wish to visit and then check the weather to figure out the best course of action. Applications that provide all this information in one place are scarce. Even when the tourist goes through with all this preparation, current weather services in some locations, especially mountain or island destinations affected by microclimates, cannot deliver weather information at the granularity needed.

Because many economies strongly rely on tourism, it is important to provide real-time weather information to meet tourists’ expectations, so they have the best experience possible and return to the destination in the future [15]. In this paper, we propose the design of a mobile application focused on providing real-time guidance for tourists seeking sunlight. The app’s main goal is to suggest the closest POIs to the user with the “best sunlight” – a combination of high luminosity with low UV intensity. Our solution empowers tourists to make an informed decision based on real-time sunlight data combined with location-based recommendations.

**Related Work**

Studies show that climate and weather are one of the most influencing factors on tourists’ destination choices [8,10]. Moreover, it affects satisfaction and entices tourists to return [5]. Many touristic activities are weather sensitive [13] and often, when faced by adverse weather conditions, tourists have to rethink their planned activities. Therefore, knowing the course of the weather allows for appropriate tactics to ensure that tourists have a good time. The amount of weather forecast information has grown; many mobile applications [21–24] make forecast information available, like the temperature comfort index, the UV index and water temperatures. However, these are usually based on predictions instead of real-time data. The importance of having real-time weather information for travelers was studied by Thakuriah [14] to predict future speeds in a traveler’s route so that they can make travel decisions relating to the weather. Recent work [6] [3] [16] has emphasized how weather information can influence the relevance of a POI to the user’s current context. In agreement with Ylipulli’s work [18], we also believe that combining climate sensitive thinking with HCI methodologies [17] is necessary when providing insightful touristic suggestions.

Inspired by the previous work, how weather and in particular how sunlight influences the tourists’ enjoyment, we propose a mobile application that provides tourists with information on a destination’s...
POIs in combination with real-time sunlight data collected by the network of sensors. We are aware that, while the sun is important for our health, exposure to sunlight carries significant health risks due to UV radiation as seen in previous work [4] [9]. That is why we also focus on UV radiation analysis, by measuring the levels of UV, and taking potential health implications into account before offering recommendations.

Tourism in Madeira Island
The island of Madeira is situated in the Atlantic Ocean. It has a mild sub-tropical climate and a diverse landscape, with 50% of the island being above 700m (2295ft). This results in the rise of various microclimates within a microclimate. Doing a quick online research on Madeira, one will find articles on how Madeira’s weather is unique [1,19] [25]. Tourism takes a fundamental role in Madeira’s economy. It represents 30% of the island’s PIB [2].

Research has shown that Madeira tourists prefer outdoor activities. They continue to consider Madeira’s weather as its most valuable asset [2,11]. Most of their morning and afternoon activities are performed outdoors and are therefore weather dependent. Due to Madeira’s microclimate, tourists are sometimes forced to quickly re-adjust their plans. Therefore, it is not uncommon to find recommendations and reviews on certain locations making references to the weather [26].

LightBeam Application
The LightBeam application helps users to find the closest POI with the “best-sunlight”. It provides recommendations based on the user’s current position and her/his preference on types of POI (Water, Mountain or City) (see Figure 1 a and b). The application also retrieves current sunlight conditions from a network of sensor nodes spread around the destination. It shows a list of possible POIs to visit, based on a recommendation algorithm developed by us. The algorithm takes several parameters into account: distance to the user, light intensity, UV irradiance and temperature. If multiple locations present the exact same conditions, the algorithm recommends the closest POI. The location with “the best sunlight”, in our approach, is a location with the highest light intensity combined with the lowest UV irradiance. Our goal with this application is for users seeking pleasant weather and sunlight to be able to maximize their vacation time.

Prototype Implementation
We used the SenseBox toolkit [2] to build two local sensor nodes that are equipped with a light intensity sensor, a UV irradiance sensor and a temperature sensor (Figure 2). The data was streamed over Wi-Fi and uploaded to the OpenSenseMap [16] platform. This allowed us to retrieve the information into our mobile application through the OpenSenseMap API [17]. The two sensor nodes were installed in two opposite locations of the island to enable us to test our recommendation algorithm. From each location, we gathered the required parameter values and attributed
individual weights to them ranging from 1-3 according to their respective units and values. We defined that the best choice would be the shortest POI with the highest (but not too high) temperature, with the most intense light and the lowest UV irradiance. Recommended POIs are sorted and displayed according to the sum of all parameters’ weights from each location. It is important to emphasize that the weights were attributed heuristically just for testing and prototyping purposes. In the next section, we mention how we intent to further optimize the recommendation algorithm to attain better results based on user contexts and preferences.

The current prototype was developed in Unity3D with Android OS as the target platform. Real-time measurement data from the sensor nodes is accessed through the same OpenSenseMap API using HTTP requests. The data was then parsed and processed in order to display the optimal recommendations to the user. The relationship between the mentioned entities is represented in Figure 3. In addition, the LightBeam app provides a short description of the POIs along with its location on Google Maps (Figure 1).

Conclusions & Future work
Our LightBeam solution helps tourists to meet their weather expectations while travelling. Our concept combines the power of spatial data from a network of sensors with the user's personal context and environmental preferences to suggest locations with the "best sunlight". To achieve this, we have envisioned and implemented an algorithm that processes different sensor parameters (Light, UV, Temperature) along with the user’s current location. We assigned weights to each of these parameters to determine the sort order of our recommendations.

Our concept raises many challenges and needs to be further validated and refined. It would be beneficial to conduct a user evaluation to focus on usability aspects and the efficacy of our recommendation algorithm. To achieve this, we will need to:

- Expand and sustainably maintain the network of sensor nodes [12]
- Improve the UV sensor data calibration
- Add further sensor data based on the location (e.g., Pollution/City; Air Pressure/Mountain)

The next iteration of the LightBeam app could integrate POI popularities by including ratings from well-known social media platforms such as TripAdvisor. Because our solution emphasizes real-time data, we also want to integrate volunteered geographical information (VGI) (e.g. Instagram photos). A valuable feature would also be the possibility for users to customize their own preferences (e.g. to a tourist travelling by car, distance might not matter as much). We also envisage to add more categories for activities, allowing users to choose the ones most interesting to them; eventually leading to a better and more personalized travel experience.

With the expansion of the sensor network, together with the advances in cloud computing and real-time data processing, the LightBeam algorithm would be substantially improved, leading to a more intelligent mobile recommender system. Before that, important technical aspects will have to be addressed. Mainly the sensor node network needs to be expanded to cover all the possible POIs around the island. Furthermore, the nodes internet connectivity needs to be improved,
because some of the islands’ POIs are not enabled with Wi-Fi connectivity. One possibility is to join an already existing infrastructure such as the one being developed by the Beanstalk research project [27]. Here a network of Wi-Fi routers could be enhanced with our sensor nodes.

Furthermore, it will be important to study how much impact the application creates in the tourist’s day. For example: are tourists following the recommendations? What impact do such recommendations might have in the local economy? Are tourists exploring more locations in the rural areas because they know that the weather is as good as in the center of the city?

References


