LiveSmart-CAMPUS: a proximity based solution for an enhanced human experience

Michela Papandrea[1], Andrea Baldassari[1], Salvatore Vanini[1], Christian Catelli[2], Dennis Nasarov[2] and Tiziano Leidi[1]

[1]*Information Systems and Networking Institute (ISIN), DTI, SUPSI, Lugano*
[2]*Proxity SA, Lugano*

Abstract

The term Smart associated to cities and communities is commonly referred to a broad concept involving vehicles, humans, environment and services. In this paper we focus on a Smart solution dedicated to a specific reality, where humans are the main actors. We propose LiveSmart-CAMPUS, an intelligent system whose main goal is to improve the life quality of students, collaborators and visitors within a physical university campus. The system will enable the management of physical distancing and the optimization of shared spaces occupancy, for a safe return to work and academic environment, during the Covid post-pandemic time. We present in this paper the LiveSmart-CAMPUS application, a mobile application developed on top of the LiveSmart global solution, and envisioned for the campus community and visitors which allows them to obtain location based, calendar and time based, and users interests' based information. The presented application will give the possibility to the LiveSmart system to collect users mobility data, allowing the monitoring and the prediction of no latency information on expected rooms and corridors occupancy levels. People who tested the applications reported its usefulness in improving their comfort and their life quality within the campus spaces.

Keywords

SmartCampus, smart mobility, LiveSmart, people, wellbeing, user experience

1. Introduction

In this paper we present the *LiveSmart CAMPUS* system: a solution meant to improve the life quality within a University Campus. A use case is presented, involving the SUPSI Campus in Lugano. The long term idea associated to the presented solution is to create a Smart Campus environment which is able to manage information delivery automatically, make smart decisions and give the opportunity to fully understand the people life situation within the campus in order to be able to provide a strategy for improving their experience.

As a fist step of this long term idea, we developed an application available for students, collaborators and visitors of the campus. The application allows the user to get involved in the campus life from both a social and a logistic point of view. The application allows the system to deliver information about courses calendar and contents, campus facilities and events etc., through a notification mechanism. Additionally, the application allows the collection of users behavioral data (e.g., mobility, interests, campus life participation) in a privacy preserving way:

FTAL'21: Conference on Sustainable smart cities & regions, October 28–29, 2021, Lugano, CH
michela.papandrea@supsi.ch (M. Papandrea)

campus visitors might decide whether to participate actively to the LiveSmart Campus initiative, by logging into the system, or they can decide to exploit the services provided by the system without exposing their identity.

The behavioral data is collected through the application in order to be able to customize the service provided to the specific users, and to design a real-time methodology able to analyse and predict mobility of users within the campus. In fact, one of the major driving motivation for the realization of the LiveSmart Campus solution is to create an intelligent system able to manage the physical distancing and to optimize the space occupancy, providing a solution for a safe return to the work and academic environment, during the Covid post-pandemic time.

In this paper we provide a brief description of the SoA and currently available solutions for the realization of Smart Campus environments (paragraph 2). Successively, paragraph 3 describes the technologies we exploited to collect users behavioral data in our use case scenario. Finally, we provide a global description of the proposed solution and more specifically, we present a mobile application for the LiveSmart system, which is the contact point between users and the Smart Campus (paragraph 4).

2. Related Works

Smart Campus is a recent trend of interest in the applied research field related to Smart environments, in fact, the smart city concept presented in literature highlights its core areas of interests which include *government*, *academia* and *industry*. The Smart Campus is, in general, a solution which allows educational institutions to combine smart technologies with physical infrastructures to improve the provided services, to automatize the decision making strategies and to improve campus sustainability, in terms of energy distribution and usage and environmental parameters management ([1, 2, 3]). Various proposed works in literature focus on specific services provided to the campus community and infrastructures: campus navigation services leveraging on the support of open map resources [4], face recognition/smart card based technologies for tracking students attendance [5], QR code based methodologies for the realization of smart parking solution [6]. Other proposed works concentrate on the technologies exploited to build a smart campus infrastructure, attempting to provide a general model for building a smart academia architecture and leveraging on the digitization of the academic life and resources ([1, 7, 8]).

Our contribution on this research topic consists in the exploitation of proximity based technologies in order to change the focus of the smart campus solutions toward an *enhanced human experience*. In order to exploit this direction we require the collaborative participation of campus living people, and especially their continuous mobility tracking within the campus. Many existing Smart Campus solutions rely on the pro-activity of the users in order to collect people mobility information, resulting in a not complete data collection and not reliable data quality (e.g., QR code based methodologies for the class-room check-in/check-out). In our work we concentrate in the collection of user mobility data exploiting an already established infrastructure and proximity based service solution based on BLE technology. The exploited mobility tracking solution, as opposite to the current state of the art, does not require the active intervention of the user for the mobility data collection and preserves users privacy (the

tracking does not require the association to demographic information). This tracking service enables many opportunities, from a reliable and responsive space occupancy monitoring and people mobility prediction system, to a proximity based information delivery strategy.

3. Data Acquisition

The LiveSmart CAMPUS system aims at autonomously learn information about users behaviour within the campus from users participatory collected data. In order to collect behavioral data the system includes a mobile application which has a twofold purpose:

- it allows the interaction of the LiveSmart system with the visiting users in a bidirectional way (e.g., the system sends to users relevant campus-related information, the user provides to the system its selection of topics of interests, for the identification of user-related relevant topics);
- it allows the collection of data about users mobility and interactions.

For mobility data acquisition, we leverage on the collaboration with Proxity SA[1] (a Swiss IT company). In particular, we exploite their Proxity-iBeacon platform solution, an intelligent solution based on a broad network of geographically distributed iBeacon devices meant for the provision of Real Time Location Services. We deployed iBeacon devices at the SUPSI Campus, expanding the coverage of the Proxity network in both outdoor and indoor campus spaces. The iBeacons coverage reaches a good accuracy with a limited installation of physical iBeacon devices (the solution relies on publicly reachable bluetooth nodes) and a complete campus coverage (i.e., it includes both indoor and outdoor campus spaces). The reached accuracy allows for the acquisition of geolocated data with the granularity of small or medium rooms. However the Campus is provided with several open spaces working and leisure environments, requesting for the set up of an iBeacon infrastructure which allows for a geo-localizzazion of the collected data with an accuracy range of approximately 3 meters. The iBeacon infrastructure together with the Proxity framework associated to the LiveSmart CAMPUS solution, allows for a continuous data collection directly from the users. The data collected by the LiveSmart application is mainly related to the people living the Campus, in particular we collect continuous data related to the places visited by the users, environmental status of the visited places (e.g., temperature and humidity), and the users interests. These data is sent to a back-end server allowing us a cumulative analysis of users behavior, which leverages machine learning techniques. The outcome of this analysis will be then exploited to provide a smart information delivery strategy.

4. The LiveSmart-CAMPUS solution

The LiveSmart Campus solution have its main focus on the *human*, and specifically on proposing a Smart way of living shared spaces, and a way of building a smart society-campus community. LiveSmart is envisioned to be a dynamic proximity based global solution which provides people a comfortable living environment wherever they move within a Campus (indoor and outdoor

[1] https://www.proxity.eu/

environments) leading to a major improvement on the way people communicate, move and collaborate, and above all on their life quality.

The data collected through the platform will allow to understand if the campus spaces, the lessons and laboratories schedule and calendar, contribute and have an impact on the students and more in general on the campus community. By leveraging the iBeacon-based Proxity solution, we are buiding the bases for a service whose main goals are:

- the management of spaces occupancy levels, in order to effectively and responsively handle overcrowded situations;
- the delivery of time and interest based notifications to students and lecturers (i.e., when reaching the Campus a student receives a message for a specific course running in the short time, getting a reminder about the room reserved for the course and the time of the lesson; a lecturer get notified about how many students of its course already reached the class room; students of a course will get notification about the teacher reaching the class room).

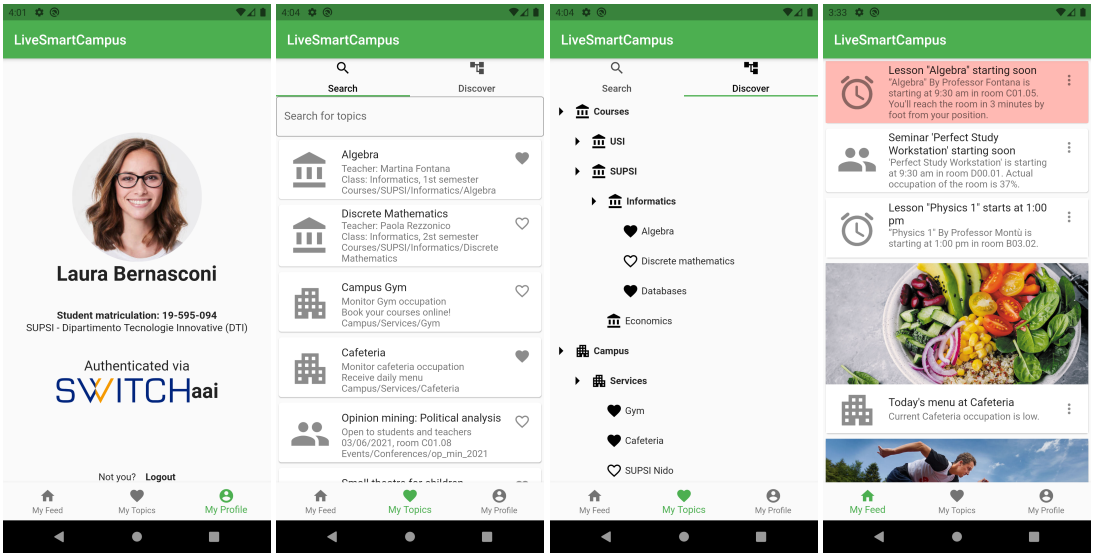
In the next paragraph we present an application developed for the interaction of the users with the LiveSmart Campus system. The application is also meant to deliver information by means of a smart delivery strategy. The LiveSmart campus solution will change the paradigm of *information delivery* within the campus, turning it in the opposite direction with respect to traditional approaches: it is not the person looking for the desired information, but is the information directly reaching the potentially interested user, at the right time and in the right place.

4.1. The LiveSmart Campus application

We developed a mobile application, meant for SUPSI students and collaborators and for Campus visitors. The application allows people to enhance their experience when living the campus, and allows them to efficiently and smoothly get involved in the Campus life. In the following we describe some of the features which are currently available on the developed application, and a set of features to be introduced later.

The application allows students to receive information about the Campus life efficiently, without the need to search or ask for it. The information received is customized, based on users' proactively specified interests and their static and dynamically inferred interests profile, and belongs to one or more of the following information categories: *(i)* general, *(ii)* location based, *(iii)* profile based and *(iv)* calendar and time schedule based.

Profile interface - Figure 1 show some examples of the application interface. In particular, Figure (1a) shows the application login interface which allows the user to login on the university web environment. The login is not necessary to fully exploit the application features, allowing its usage also to external visitors. For campus students and collaborators, the login allows the connection of the application with the university account (registration number). Each logged user is associated to a role, according to their position within the university, and she/he is accordingly provided with a different set of permissions. For example: students have the permission to only receive notification and specify personal interests; while lecturers can both



(a) (b) (c) (d)

Figure 1: SUPSI LiveSmart-CAMPUS Application interface

receive and push notifications to specific targets of users (i.e., a teacher might push notifications to all the students of its class, physically present during a lesson); the administrative or logistics staff can push notification to all students and campus visitors (i.e., alarm messages, urgent information). Additionally, each logged user is associated to some specific targets (i.e., the belonging class or group target, the courses she/is registered to), allowing an initial predefined association of interests which the user will be able to edit successively, through the application itself.

Topics of interest - Figure (1b) and (1c) show the application interfaces which allow the user to proactively specify *topics of interest*. The selection of a topic of interest allows the user to be associated to a target, and hence to receive all the messages intended to the target group of users. The targets have a hierarchical structure and its initial content is defined a-priori. A collaborative approach is applied in order to have a dynamical evolution of the corpus of topics, in accordance to the actual interests and necessity of the campus population. The topics are divided in three main categories:

1. *Courses*: this category includes all the targets defined a-priory and associated to the enrollment information of each student (e.g., enrollment faculty, present attended semester, present enrolled courses, belonging class) or to the activities of each lecturer (e.g., the courses held, the associated classes). All the topics included in this category are related to the academic curricula, offers and schedules.
2. *Campus*: this category includes all the targets related to the life within the campus (e.g., restaurants, gym, kindergarten, library, transportation). The user might manually specify the personal interests among a set of existing targets in order to receive the related notification, as for example the menu of the day at the campus restaurant, or the new

course available at the Campus - gym, or the notification about the imminent bus arrival at the Campus bus stop.

3. *Events*: this category includes all the targets related to temporary events, competitions, talks and brainstorming meetings organized from the campus users. Exploiting the topics of this category, users can get informed and get involved with the social life of the campus.

The topics of interest are accessible both in a hierarchical representation, allowing the user to look for the available set of topics by navigating through the hierarchy (Figure 1c), and in a direct search interface (Figure 1b). The evolution of the application will give us the possibility to insert additional levels in the hierarchy of the topics, as for example allowing to differentiate between *public* and *private* topics. In the case of private topics, these will not be listed in the hierarchical discovery interface, but the users will be able to personally invite other people to like the topic, allowing for the creation of communities. Additionally, a recommendation system will support the application, in order to infer and suggest topics of interest based on users and population behavior. The evolution dynamism of the topics population will be managed in order to maintain an equilibrium of its dimension: new topics will be included and not interesting ones will be removed from the hierarchy, ensuring the responsiveness to people requests and necessity with time.

Feeds - Figure (1d) shows the application interface which allows the user to visualize the received notification. When the user specify a topic of interest, she/he will receive push notifications related to that topic. The complete list of notification contents (*Feeds*) is visible on the *My Feeds* interface, allowing the user to disable the notification mechanism and to still be able to access the personal list of potential interesting information. Each Feed is visually associated to an icon which represents the main category of the related topic of interest (e.g., Courses, Campus, Events). Feeds are ordered by notification arrival time and related time schedule, and are associated with an expiration time and with an urgency ranking value, in order to be able to highlight urgent feed within the interface (i.e., information about a lesson which is about to start). The set of information visible on the *MyFeeds* interface can be edited by the user, selecting or disabling the interest to specific topics (through the *My Topics* interface): when the user removes a topic of interest from her/his selected list, the related feeds will be removed from the Feeds interface.

Notification - Information are not only accessible through the *My Feeds* application interface. The LiveSmart CAMPUS application integrates a smart information delivery strategy, in the form of a notification mechanism. The user receives asynchronous notification messages about services related to the specified topics of interest. Notifications are delivered according to the position of the user (i.e., users receives the daily menu when moving in the proximity of the restaurant), according to a time schedule (i.e., approaching an event start time) or when the user reaches the Campus. The notification strategy is mean to work only within SUPSI, but the user might decide to receive notifications also when outside the campus.

4.2. The Smart information delivery strategy

The main innovative aspect of the proposed LiveSmart CAMPUS solution and application consists in considering the human as the main factor for the formalization of the various

optimization strategies whose goal is to maximaze the wellbeing and to improve the experience when living the campus. The students, the university collaborators and all the visitors in general should feel comfortable and welcomed when visiting the campus, and should enjoy their experience. To achieve this goal we concentrate on the user and we apply machine learning based methodologies in order to perform behavioral analysis. This analysis allows the LiveSmart CAMPUS system to infer the users interests and preferences to learn which are the predominant behaviours and identify eventual anomalous behaviors. The results of this analysis allows the implementation of a *Smart information delivery strategy*, where the information is not only delivered at the right time (i.e., according to some time schedule) and in the right place (i.e., when the users is moving in the proximity of a certain service), but also to the right users (i.e., according to some user's specified or statically associated topics of interests, and to some dynamically inferred ones).

5. Conclusion

In this paper we presented *LiveSmart CAMPUS*, a project whose goal is to maximize the well-being and to improve the experience when living a university campus. With this goal in mind, we developed in the scope of this project, and presented in this paper, an application for smartly deliver information to the campus population. The application has been tested by a group of students and collaborators, which reported its usefulness in improving their comfort living the campus spaces. The application allows the collection and the real-time processing of behavioral data, paving the way for the creation of a global Smart Campus reality. Demonstrating the feasibility of our approach in a university campus will provide a proof for the technologies and the methodologies that could be used to build Human-Centric Smart Cities.

References

[1] N. Min-Allah, S. Alrashed, Smart campus—a sketch, Sustainable cities and society 59 (2020) 102231.

[2] W. Villegas-Ch, X. Palacios-Pacheco, S. Luján-Mora, Application of a smart city model to a traditional university campus with a big data architecture: A sustainable smart campus, Sustainability 11 (2019) 2857.

[3] M. W. Sari, P. W. Ciptadi, R. H. Hardyanto, Study of smart campus development using internet of things technology, in: IOP Conference Series: Materials Science and Engineering, volume 190, IOP Publishing, 2017, p. 012032.

[4] M. A. A. Maidin, F. Ahmad, N. I. Abidin, J. Suhaili, M. Awang, M. A. A. Rahman, M. K. Musa, N. Hamidon, F. M. Yusop, M. S. Syazwan, et al., Design campus map using openstreetmap digital software, in: Proceedings of the 3rd International Conference on Separation Technology, Springer, 2021, pp. 113–129.

[5] S. Sawhney, K. Kacker, S. Jain, S. N. Singh, R. Garg, Real-time smart attendance system using face recognition techniques, in: 2019 9th International Conference on Cloud Computing, Data Science & Engineering (Confluence), IEEE, 2019, pp. 522–525.

[6] D. Brown, S. Hong, A design of an automated parking system on a smart campus., Issues in Information Systems 20 (2019).
[7] X. Liu, A study on smart campus model in the era of big data, in: 2016 2nd International Conference on Economics, Management Engineering and Education Technology (ICEMEET 2016), Atlantis Press, 2017, pp. 919–922.
[8] R. Jurva, M. Matinmikko-Blue, V. Niemelä, S. Nenonen, Architecture and operational model for smart campus digital infrastructure, Wireless Personal Communications (2020) 1–18.