Ambient and Aesthetic Intelligence for High-End Hospitality

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Abstract. The core value proposition for most hospitality brands is to provide unique customer experiences; therefore we expect commercially viable opportunities for Ambient Intelligence systems in hospitality in general, and the high-end sector in particular. We believe that Ambient Intelligence systems paired with principles of Aesthetic Intelligence could facilitate such unique experiences and at the same time strengthen and differentiate the brands. This paper gives an overview of challenges in this field, reviews research and outlines future scenarios enhancing safety, economic optimisation and – especially - convenience for hotel guests.

Keywords: Smart Hospitality · Business Applications for Home/Leisure · Technology and Branding · Smart Environments · Personalized Services · Aesthetic Intelligence · Ambient Intelligence

1 Introduction

Research in the field of Ambient Intelligence has covered a variety of applications, many centered on smart homes and offices, and rather little attention has been paid yet to its application in the hospitality industry. Most hospitality brands' value proposition is centered around creating unique customer experiences. We believe that strategies for "smart hospitality" based on Ambient Intelligence can offer commercially viable opportunities. Especially the field of Aesthetic Intelligence [3, 4, 5, 6] with its focus on the conceptual and perceptional aspects of technologies may be able to contribute to shape such unique experiences. Aesthetics are also at the core, when it comes to strengthen brand value and differentiate brands from other competitors. The implications for "smart hospitality" are potentially huge with an annual volume of global travel accommodation sales in 2013 of US$670.861 billion [7] while the volume of global hotel sales in 2013 was recorded as US$488 billion [7]. Within this market, the hotel segment is expected to be the early adopters.

This paper first provides an overview of existing research in Ambient Intelligence for smart homes and hospitality, followed by a few examples of how concepts and technologies from Aesthetic and Ambient Intelligence could be combined to provide

new high-end hospitality services. We chose to concentrate on the high-end segment of the hospitality industry since innovations are often earlier adopted in the premium markets.

2 Challenges For Hospitality

It is challenging to apply existing technology into the hospitality industry. The majority of Ambient and Aesthetic Intelligence studies [see, e.g., 11, 12, 13 or 14] are designed for the use in homes and not in transit stays. Even though both settings may be considered as living environments, there are crucial differences between homes and hospitality rooms. For example, users as guests may have very different expectations towards a premium priced temporarily available space in a resort than to their daily living environment. They may rent a room, suite or villa more likely for its unique experiential value than for mere accommodation purposes. Unsurprisingly, guests pay higher for a unique level of service and expect an immersive experience.

A main challenge for all ambient technologies is the potential degree of intrusion and violation of privacy – in legal but perhaps for hospitality more importantly, in emotional terms. Hotel guests tend to be highly aware of details of the environment and services provided. Although they generally appreciate intelligence catering to their habits and preferences, such services need to be based on data obtained via non-intrusive methods [15, 16, 17]. Ambient Intelligence should observe surrounding and aesthetically adapt to deliver personalized services [18] without crossing the line of intrusion to gain public support. In this respect, the European Union Information Society Technology funded a collective initiative that produced the European Privacy Design Guidelines for the Disappearing Computer [35]. This guidelines deal with amongst other things, privacy challenges of ambient intelligence. One of the guidelines includes applying the "privacy razor" that eliminates any information that is not "absolutely necessary".

Another challenge is that the time for configuration of devices is rather limited during temporary stays. Transit stays imply that there is short period of time for devices to learn about guests' environmental demands. Unlike smart homes where devices can use descriptive and predictive analytics to interpret, anticipate and respond to an individual's habits, transit stays do not allow for such predictive analytics. While in homes people generally are inclined to routines, this does not apply to tourist's use of hotel rooms. As such, identifying personal preferences becomes even more challenging in the hospitality sector, impeding the sufficient collection of data.

In addition, since hospitality environments are highly depending on the perception of their guests, there is a need to understand the relevance of beauty and aesthetic values for these Ambient Intelligence technologies. Aesthetically pleasing design for usability, technology acceptance, and well being in technology-enhanced spaces are likely to gain additional importance in the future. With the concept of "aesthetic intelligence" [34] we refer to the related conceptual, visual and methodological competencies required by designers and technology developers. Aesthetic intelligence highlights the "conceptual

soundness" beyond the mere beautification of interfaces or designs. It stresses the importance of intersecting brand values, cultural values and an understanding of meaningfulness of the target audiences, for the creation of aesthetic systems. We will drill here not into the details of aesthetic intelligence as a set of methodological heuristics, but want to highlight its importance in relation to brand building in general and its applicability for the creation of user experiences in retail and hospitality environments.

3 Existing Research

To understand the applications of Ambient Intelligence in the hospitality sector, we consider existing studies in domains, smart homes and hospitality. There have been extensive studies on Ambient Intelligence in smart homes; many of those findings seem to be transferrable to hospitality accommodation. We will highlight some of them in this section. We will refer also to some earlier Ambient Intelligence studies directed towards the hospitality sector; many of those could benefit from current technological developments.

3.1 Studies In Smart Homes Applicable To Hospitality

Since home and hospitality settings share common features, research findings on smart houses may be transferable. Granted, the tracking and sensing technologies in the Aware Home project [26] can assist hospitality industry in solving loss and theft scenarios. Using RF tags and long-range indoor position system, the Aware Home is able to locate misplaced items. Another research center, which could support studies for hospitality related scenarios, is the Assisted Living Laboratory [31]. Using basic technology and measurements of environment, it aims to assist elder living. It automates with ambient sensors based on European Installation Bus to keep track of the resident's activities. It also uses position-tracking solution such as Radio Frequency Identification (RFID) tags mounted in the ceiling, ultrasonic and radio frequency based movement sensors.

The technologies used in the assisted living laboratory, while designed for the elderly, can be transferred into developing Ambient Intelligence in the hospitality industry, such as to collect data of guests' habits. In addition, by identifying repetitive patterns observed by sensors and predicting likely future activities with compression-based predictors, MavHome automated interactions with the environment by 76%, on average [23]. Although limited in numbers, successful applications in smart homes such as those by MavHome might also be useful in the hospitality sector.

3.2 Studies In Hospitality And Tourism

While existing studies directed towards the hospitality industry provide an alternative perspective, not many seem to be informed by current ideas from Ambient and Aesthetic Intelligence. Leonides et.al [1] in their work on the Intelligent Hotel Room (iHR) seek to provide an ambient ecosystem that "observes its surroundings and adapts its

behavior in real-time to deliver intelligent and personalized services to its guests" that contribute to a more seamless travelling experience. The suggested infrastructure includes a portable room controller, intelligent touch panel, universal remote, hotel explorer, doormat device and a digital room butler.

To control devices in the hotel room remotely, studies can tap into the test-bed of the University of Essex's intelligent dormitory (iDorm) [24], which allows any networked Java-enabled computer to access and control iDorm through its Universal Plug and Play (UPnP) [25]. However these researches seem still at its infancy and suggestions do not fully tap effectively into Ambient Intelligence. The concepts of the "disappearing computer" [19] proposed that users no longer need a "portable room controller" or "intelligent touch panel" [1]. Essentially, these slightly dated studies do not fully encapsulate today's potential that ambient and aesthetic intelligence possess.

4 Opportunities For Applications In Hospitality

The aesthetics [3, 4, 5, 6] and "look and feel" of technological solutions are perhaps more important for hospitality than for many other commercial domains. Ambient and Aesthetic Intelligence can provide revitalized user experiences bolstering the brand. Due to social networks, consumer decision-making is highly informed by the opinion of others and viral effects can affect branding quickly and powerfully in both positive and negative ways [9]. Brands in the hospitality industry looking to improve their reputation management will be able to tap effectively on aesthetically sophisticated ambient intelligent solutions.

There are three major components for innovations in the field of Ambient Intelligent for hospitality environments: safety, economics and convenience. The first two components can be easily adapted from existing approaches. The main field for new applications we consider is in the category of convenience given its central role for hospitality brands.

4.1 Safety

A challenge in hospitality lies in providing safety in an environment filled with strangers. This poses a special emphasis on safety, though standard approaches seem to be applicable. As mentioned previously, non-invasiveness might have a higher priority than in private environments – finding an optimal combination of security and surveillance technologies without invading the guest's experience.

Non-invasive monitoring, through position-tracking solutions can elevate the security level in this sense effectively. The actions of guests having access to the room can be monitored and assistance can be given if a harmful situation is developing [29]. As compared to recording cameras, there is less intrusion using position-tracking solutions.

Apart from aiding physical accidents, harmful situations occur from unauthorized access of individuals. For example, in theft cases it might be difficult for the hotel management to make a judgment on staff theft and a guest's loss of items. Non-invasive monitoring can also identify if room attendants have unusual patterns or act differently

from designated routines. Combined with tracking technologies that identify loss items, the confusion between theft and misplacement can be avoided. Security systems like this will have deterring effects.

4.2 Economical Optimizations

It has been well established, that Ambient Technology can help to optimize the use of resources. These approaches can easily be transferred to the hospitality environment. Optimization through customization is an obvious example: by using Ambient Intelligence integrated into the physical environment [20, 21, 22], the industry will be able to customize various facilities to individual guests and control energy usage at different times of day: ideal degree of light, position of curtains, frequency of changing sheets and towels, temperature of water in bath tub, television channels, music and radio channels.

Learning algorithms tracking the movement of guests allow the temperature of a room to be prepared in advanced, yet without having to leave the air-conditioners/warmers on throughout the day. Currently, travellers who wish to return to a room at a desirable temperature have to leave their conditioners/warmers on throughout the day.

In spite of cost-saving efforts by hotels to power electricity of rooms via key cards, travellers often circumvent this process with card substitutes to keep the air-conditioners running, causing inefficient uses of electrical energy in the hospitality sector. An example of a project outside of the hospitality sector that addresses intelligent use of energy is Ambient Lighting Assistance for an Ageing Population (ALADIN) [30]. It translates the impact of lighting on wellbeing of older people into a cost-effective open solution.

Today commercial thermostats that track habits and adjust accordingly are available for homes such as those sold by Nest [27]. The improved interfaces and remote access of such devices tighten interactions between human and systems [28]. However, the necessary "learning" time of such devices is not always applicable to the hospitality industry due to the frequent occurrence of short stays. Nevertheless, with increasing connectivity [2], hotel chains might gather information through a series of stays and culminate collected information. This represents an opportunity to offer a higher value to guests while reducing costs through energy savings.

4.3 Convenience

Improving convenience in hospitality we consider the area with perhaps the highest potential for innovation. A variety of new applications can be envisioned around personalization, informational enrichment and atmospheric improvement.

Most guests, even in luxury hotels, do not have the privilege of receiving personalized services. Given the lack of information, housekeeping departments apply a general service for all clients. For example, a common practice in hotels and requirement for

five-star rating is a "turn-down service" that includes entering a guest's room to close the curtains, turn on night-lights and prepare indoor footwear. This practice engenders privacy issues that can be ameliorated via Ambient Intelligence technologies.

Privacy can be bolstered when Ambient Intelligence supports or even substitutes tasks of room attendants, who might not necessarily have to enter a hotel room anymore to fulfill the various daytime service. This again represents an opportunity for customization through automatisation. Long-term guests of hotels or serviced apartments enjoy the privilege of having room attendants learn their preferences, such as guests preferring curtains opened throughout the day or otherwise. With Ambient Intelligence, these tasks can be customized to the guests taking into account their preferences for water temperature during bath and showers, sauna and spa [32] etc. Reminders for desirable routines such as health-related activities or medication can also be easily communicated.

Another scenario could include protection from environmental nuisances, such as insects: especially in tropical climates electronic insect deterrents could be automatically triggered during the dusk and dawn hours or after rain for the outdoor areas, private balconies and verandas without any intrusion.

Convenient for business guests and travellers requiring frequent communication should be a video-telephony system, such as the one embedded in the Assisted Living Laboratory [31]. As guests expect a higher level of technology and customization based on their stored preferences [10], the range of demands will expand and Ambient Intelligence provides a solution to quickly learn and meet individual needs. Or, one may envision voice recognition combined with a database so that when a guest hums a few bars of a song, the sound system of the room can retrieve and play the respective audio file [33].

Travelling implies – for most individuals - being in an unfamiliar environment. Therefore we spot opportunities for systems, which more or less explicitly offer educational information about the local culture, language, cuisine, flora and fauna etc, the immediate vicinity of the hotel, logistical support regarding travels and so on. For example, sensors in a guest room may recognize in real-time the exotic birds outside singing displaying some information about the bird. Basic language skills and gestures, the recipe of a dish conveyed as short media snippets might be nice "take-aways" from a stay. The collection of environmental data such as the cleanliness of air, clarity of water and timings of specific natural events will be also valuable to customers. Gameification, real time analysis of data, tapering into the pool of mobile and social media applications open a wide range for innovations.

We also identify opportunities for what we may call "atmospheric improvements". An interesting challenge could also be reconciling the apparent opposition of nature themed environments with high tech. Premium tropical resorts especially in Asia are designed with natural materials yet creating sophisticated aesthetically cozy environments often emphasizing health and wellness in a setting of tranquility.

Conveying atmospheric information between different parts within larger resorts such as private spaces, the hallways and the public areas could prove useful. For example, ambient displays may communicate crowd-sensing data from the buffets, the

beach, the pools etc. Here video images would violate a sense of privacy, yet atmospheric displays [36] could provide helpful and anonymous atmospheric information. Especially in larger resorts this may help to avoid unwelcome over crowding during peak hours and let guest's make informed decisions. Such mechanisms may also attract attention for social events, tours or sites and may serve as a subtle real-time marketing channel.

Ambient Displays and light dramaturgy are effective means for creating subtle atmospheres. They may display decorative or atmospheric visuals via video or still imagery, e.g. soothing landscapes. Real-time feeds from the region or vicinity of the hotel (beach, sunset etc.) might be of interest. Gentle light modulations imitating a sunrise can in future substitute the wake up call, if wanted [32].

Providing silence and the absence of noise could be a new feature for luxury environments, especially those targeting wealthy "silver" clientele. Audio profiling of rooms ("sound profiles" for the various room types, e.g. pool view, sea view, mountain view) could be new category of marketing different areas within a hotel. Guests may then be able to request particularly quiet rooms.

5 Conclusion and Further Work

In this paper we focused on three core aspects of Ambient Intelligence: safety, economical optimisation and convenience. We believe, there is significant potential in the hospitality industry to make use of ambient intelligent systems in combination with principles of Aesthetic Intelligence to create new customer experiences.

We offered a selection of proposals how Ambient Intelligence could be applied and consider the sector of convenience the most promising one. Ambient technologies can be used to enhance environments with information, education, and logistical explicit information. They may also be applied to create subtle atmospheres, through light, sounds, the absence of sound as a new and recreational quality etc. We feel that there is huge potential for new applications and ideas, either through developing new functionalities or through the combination of existing technologies (real-time sound analysis app "singing bird detector" e.g.). These may include ambient displays in combination with data from crowd sensors in order to influence the guest's decision making within the hotel premises.

We also highlighted the special challenges for the hospitality industry: balancing safety and surveillance technologies with the high preference for non-intrusiveness seems of high importance. Also integrating technology in nature themed ambiances, which are quite common for most tropical high-end resorts, is a particular design setting, where the idea of the disappearing computer and ambient intelligence literally seems predestined to offer solutions.

For research in the field of Aesthetic Intelligence the hospitality industry seems a very fruitful domain to test and explore heuristics for the design of aesthetic systems, especially in relation to building brands. In combination with social media – before, during and after the stay may also open up new possibilities; we did not touch upon those here, but they could be explored in future research.

Overall we assume, that the high-end hospitality could become an innovation driving industry for the application of ambient intelligent systems. Similar to the role of luxury brands, from these premium services the mass-market suppliers may benefit and adopt strategies for the future. We could imagine, that the high-end hospitality industry could help to explore and establish highest standards for Ambient and Aesthetic Intelligence. There seems an abundance of opportunities for the progress of luxury hospitality through new applications and research offering feasible, yet innovative and commercially viable perspectives.

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