The importance of integrating Internet of Things, big data and cloud computing into linguistic landscapes

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Abstract

Although the Internet of Things (IoT) is an emerging research area which has brought significant advantages for smart homes and smart building applications on the whole, these implementations are still very rare for linguistic landscapes (LLs). Based on a comprehensive literature review, this paper aims to contribute towards narrowing the gap between the employment of the IoT advanced technologies and their proper integration into smart LLs. The analysis focuses on IoT, Big Data, Cloud Computing, LLs, and the challenges and existing solutions, in order to effectively integrate cloud-centric IoT for smart LLs. The paper additionally proposes a framework which involves three main levels comprising different components from IoT, the big data and cloud computing literature that are mostly required for IoT-based smart LLs solutions. Finally, suggestions for the successful integration of IoT into LLs are presented together with future directions for research in this area. The key rational behind this study is to improve the quality of life for people utilizing IoT tools and techniques

Keywords : Internet of Things, IoT, Linguistic Landscape, LLs, Big Data, Cloud Computing

I. Introduction

IoT, Big Data and Cloud Computing

The term Internet of Things (IoT) is defined as a network of interrelated physical things (i.e. objects/devices) embedded with sensors, processors, software, and network connectivity capability to enable them to exchange data with each other or with the manufacturer/operator of the connected devices (Botta, De Donato, Persico, & Pescapé, 2016; Stair & Reynolds, 2017). IoT rely heavily on several important components such as the Radio-Frequency Identification (RFID) systems and Wireless sensor networks (WSNs) (Botta et al., 2016; Kosmatos, Tselikas, & Boucouvalas, 2011). RFID comprises several tags and readers to assist identifying anything they are attached to, allow objects to be integrated into a grid that provide information and services. The wireless sensor networks, on the other hand, paly a key role on the success of IoT by assisting in better tracking of things and getting important information such as movement, position, temperature, lightening, etc. They work collaboratively with RFID systems to gain precise information about the things that are connected (Albishi, Soh, Ullah, & Algarni, 2017). The sensors in this scenario communicate and exchange information wirelessly and overall help in providing useful information for analysis to many institutions in different areas such as government services and healthcare providers in order to maintain quality of services (Botta et al., 2016).

While numerous things are connected or to be connected within the IoT environments, two terms have been widely linked to IoT. These are Big Data and Cloud Computing. Big data is a term used to define collections of data that are so huge and complex that makes it difficult for classical/traditional database management software and hardware to analyse, process and manage such a volume of data (Stair & Reynolds, 2017). The big volume of data transmitted from the connected devices/objects is constantly requires storage and analysis, in order to gain the required benefits of IoT technologies. Big data technology handles the huge amount of data through four main steps; data collection, data processing, data analysis, and data execution (He et al., 2017). Characteristics of big data is not only involve volume but also velocity (i.e. the timeliness of data including; data collection and analysis in real time to inform the decision making process), and variety (i.e. various types of data is handled such as video, text, and audio). Big data with advanced data processing techniques has proven to be vital and gained many successes over the recent years (He et al., 2017). Cloud computing, on the other hand, was defined by The National Institute of Standards and Technology (NIST) as "cloud computing is a model for enabling ubiquitous, convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction." (Mell & Grance, 2011). Thus, cloud computing encompasses all required infrastructures that are vital for IoT network/system to transform buildings, roads, services, and many others into smart where tasks can be accomplished in more effective and efficient manners (Stergiou, Psannis, Kim, & Gupta, 2018). The following section covers the LLs which is considered as a part of these areas that requires IoT to be smart and gain the required improvements. Such advancements can make better shopping, discovering, and navigating experiences for the intended population.

Linguistic Landscapes

Language plays a principal role in people's lives all around the world, being used for many essential life tasks such as learning, teaching, communication, expressing thoughts, among others, and can be considered as a mirror of the human mind (Chomsky, 1986). In the past decades, scholars have produced a significant body of research relevant to language studies. One specific major that comes under language studies is linguistics which is the science of language that puts emphasis on how human language has been structured and and identify why people write/speak differently in different social contexts (English & Marr, 2015). The study of the linguistic landscape (LL), which comes under the linguistic discipline, focuses on public signage and covers all of the linguistic objects that mark certain places such as shopping centres, schools, universities, and airports etc. According to LL was initially defined by Landry and Bourhis (Landry & Bourhis, 1997), who stated “the language of public road signs, advertising billboards, street names, place names, commercial shop signs, and public signs on government buildings combines to form the linguistic landscape of a given territory, region, or urban agglomeration”. LL has demonstrated an important area for investigating the dynamics of major aspects of social life mainly because it both shapes and is shaped by social and cultural associations (Li, 2015). Signs which shape the LL are usually classified as either official, such as guidance signs produced by higher authorities such as the local government or the Council as the governing body of a university, or as non-official as in commercial contexts such as advertising and marketing, in which their purpose is to draw attention to certain products or services (Backhaus, 2007). They disseminate messages to the target audience in both informational and/or symbolic forms.

II. Study Context: Lalor Shopping Centre

The Lalor Shopping Center is one of the most renowned marketplaces located on Station Street and May Road, Lalor (North Melbourne), Victoria, Australia. The Centre involves approximately one hundred businesses and services in a single compact locale. It encompasses a mixture of restaurants, cafes, fresh food stores, and gifts shops together with other professional businesses including clinics, legal advisors, and banks. It is governed by the City of Whittlesea Council, a local government council. The council has a wide range of responsibilities including but not limited to: providing and supporting services to the local community, protecting the cleanliness and safety of the community, and preventing pollution, noise and disease (City-of-Whittlesea, 2017), services that often engage creating, interacting and viewing signage.

The suburb at large was named in an honor of Peter Lalor, a leader of the Eureka Stockade rebellion and later member of the Victorian parliament. Lalor has a population of over 19,873 people according to the latest release on population by the Australian Bureau of Statistics (ABS, 2011). According to the City of Whittlesea, 65% of the population speak a language other than English at home (City-of-Whittlesea, 2011). The most common languages are Arabic with 10.24% of the population, Italian with 10.00% of the population, Macedonian with 9.91% of the population, Greek with 8.10% of the population, Vietnamese with 6.52% of the population, Punjabi with 3.28% of the population, Turkish with 2.45% of the population, Hindi with 1.22% of the population and Mandarin with 1.02% of the population (City-of-Whittlesea, 2011). These diverse groups reflect intensely on the linguistic landscape of the Lalor Shopping Centre. Languages that are presented on signage at Lalor Shopping Centre included many languages such as: English, Arabic, Persian, Italian, Greek, Urdu, Vietnamese, Turkish, Mandarin, Punjabi, Macedonian, Cantonese and Maltese.

For the purpose of this paper, the combined blocks of Lalor Shopping Center, located between the corner of David Street and Station Street to the corner of May Road and Messmate Street as shown in Fig. 1. In previous research on LLs, the selection of appropriate shopping centers was vital, especially where the population in the surrounding areas is highly diverse, comprising migrants from different countries with varied cultural and linguistic backgrounds (Gaiser & Matras, 2016; Roeder & Walden, 2016). The suburb of Lalor where the shopping is located has a highly rich and diverse population, with the specific selection of a single shopping center was necessary to focus efforts on an area of a manageable scale in accordance with the limited time and resources given, which enables the comprehensiveness and rigor of the analysis.

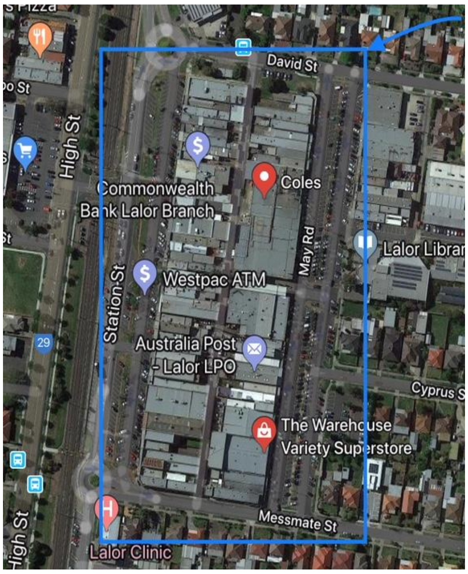

Fig. 1. The study area highlighted by the blue line indicating the combined blocks of the Lalor Shopping Centre under investigation (source: Google Maps)

Fig. 2 below demonstrates examples of Lalor Shopping Center LLs.

Fig. 2. Multilingual commercial sign using English, Arabic, Persian, and Vietnamese, taken from the Lalor Shopping Centre

As shown above, traditional LLs involve standard signs that include text, colours and symbols put together into a spatially definable frame. Nowadays, signs are becoming more advanced due to the employment of technologies and multimedia. For instance, instead of using traditional static signs that incorporate printed text and remain in place for a long period of time, more dynamic signs have now evolved where the use of small screens replaces traditional signs. These screens can be fluid and dynamic especially when they are connected to computers, which enables their content to be updated as required. These features can be further supplemented by incorporating additional forms of multimedia, such as voice messages, which can attract the attention of the target audience. The use of small video displays in shopping malls has increased enormously and is becoming part of the LLs (Gorter, 2013). Having such flexibility can assist shops owners to update the content of their signs in an efficient manner and enable their consumer to make informed shopping decisions.

In recent developments, digital signs have become interactive, allowing users to touch the screen to find out more about certain information, directions, and services. The content of digital signs can be updated remotely when connected to a server or by attaching a special antenna that enables connectivity for updating purposes (see Fig. 4). The employment of these digital and interactive signs can significantly improve the LL of any shopping center, especially when they have been equipped with specialized marketing resources that enable consumers to interact and gain specific information while navigating around the shopping buildings.

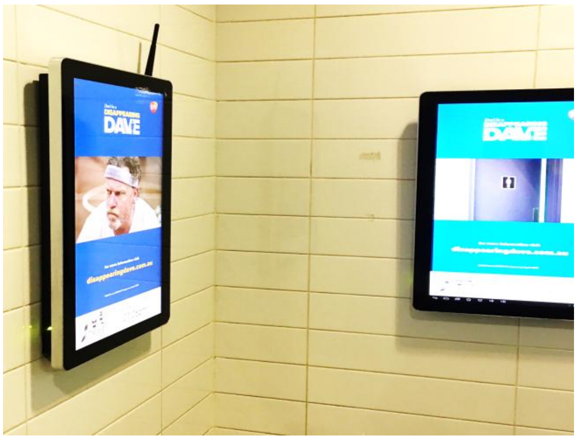

Fig. 3. Digital signage supported by antenna for remote content update purposes (Photographed at Melbourne Tullamarine airport, 2017).

LLs can be used to assist visually impaired people. A traditional way of designing signs includes the use of non-visual methods of information representation such as Braille (Shen & Coughlan, 2012), which is a system that enables blind and visually impaired people to read and navigate through buildings via touch. However, more recently, with the increased use of multimedia and technology, smart signs can now help visually impaired people even further in a more efficient manner. Hyun and Ravishankar have recently designed a Smart Signage system encompassing three main components (i.e. an assistive long cane supported by a Bluetooth low energy receiver, a smart tactile sign, and a smart phone) as shown in Fig. 4 (Hyun & Ravishankar, 2016). So, when a visually impaired person approaches this sign, signals are automatically exchanged between the sign, the cane, and the user's app and information/instructions are provided, resulting in the visually impaired person being able to better navigate the shop/place and have greater accessibility to the site they are visiting. This information can be directive, for example, to indicate where the toilets are located or can be informative and provide specific information. Hence, such technologies can contribute positively to shaping the shopping' LLs in ways that consider consumers with special needs.

Fig. 4.A smart signage system to help visually impaired people (adapted from (Hyun & Ravishankar, 2016)) and reproduced by the author

III. IoT and Smart LLs

A review of the literature shows that the integration of IoT into cities (Zanella, Bui, Castellani, Vangelista, & Zorzi, 2014), buildings (Zafari, Papapanagiotou, & Christidis, 2016), homes (Risteska Stojkoska, Trivodaliev, & Davcev, 2017), and environments (Ahmed, Yaqoob, Gani, Imran, & Guizani, 2016) has turned them into smart places, where task handling is more effective and efficient. In this section, a three-level framework (i.e. the object level, the communication level and the application level) comprising the required components for the successful integration of IoT into LLs is presented, based on a thorough review of the literature on similar contexts.

The Object Level

At this level, every shop must be equipped with sensors and wireless connectivity. The sensors can be attached to the shop sign. Connected sensors can then sense, actuate, process data and communicate through the shop wireless networks in a similar way to smart homes (Byun, Jeon, Noh, Kim, & Park, 2012). In some cases, sensors can perform certain data processing prior to communicating with components of the communication level, such as hubs and the cloud (Viani et al., 2013). Sensors can detect nearby customers who have a smart gadget with the relevant application installed and disseminate personalized information and offers in a timely manner. Therefore, shop owners can provide and deliver updated information regarding their products and services to the cloud in order to ensure that they gain the maximum advantage from such technologies. The object level is demonstrated in Fig. 5.

The Communication Level

In this level, two main components must be considered, the hub and the cloud. The hub is a device responsible for gathering raw and/or analyzed data from smart objects and sends them to the cloud for processing and storage purposes. In order to reduce the amount of data flowing to the cloud, hubs have to execute local data processing after the data has been gathered or collected (Viani et al., 2013; Zhu, Wang, Chen, Liu, & Qin, 2010). As in a smart home scenario, the hub sends commands to smart objects acting as a local regulator or planner (Byun et al., 2012). For the purpose of this paper which aims at developing smart LLs, the hub is called the LL hub, as shown in Fig 6. While communication between smart devices/objects is difficult (Gubbi, Buyya, Marusic, & Palaniswami, 2013; Heile, 2010), hubs are required to understand the communication protocols used by these objects and regulate the data flow between them or to the cloud. The other component that is important for the communication level is the cloud and is the component responsible for storing data (Zhou et al., 2013). In the smart LL scenario, customers have a specific application installed on their smart devices, and product information from nearby shops is received from the cloud. Sensors for the nearby shops sense and communicate relevant information to the cloud through the LL hub. For instance, a customer may be interested in buying a certain product. In this case, the customer is required to open the application on arrival and enter the desired product/service in order to enable the smart IoT-based LL system to provide a list of available products/services within the shopping area. Both components are depicted in Fig. 5.

The Application Level

At this level, the external party should be involved in the design and development of an appropriate application for user/customer interfaces. The application should provide users/customers with guidance on how to utilize such an advanced asset in an effective manner. Due on the effective use of this application, the customer will have the advantage of saving time and making informed shopping decisions. For example, there are three pharmacies in Lalor shopping center, so when a customer wants to buy a specific hair lotion, they can obtain a price list from all three pharmacies using the application and choose the best option rather than walking into each pharmacy and searching for a certain product. In a similar context (i.e. a smart home), the developed applications take into account personalized recommendations in order to provide the customer with more efficient experiences through IoT technology (Liu, Yang, & Liu, 2014). The application level is presented in Fig. 5, taking into account the external components of the network that exchange additional information with the cloud through the utility connection (Sajjad, Napoli, & Chicco, 2014) and the required energy production, transmission and distribution for IoT-enabled smart LLs at Lalor Shopping Centre.

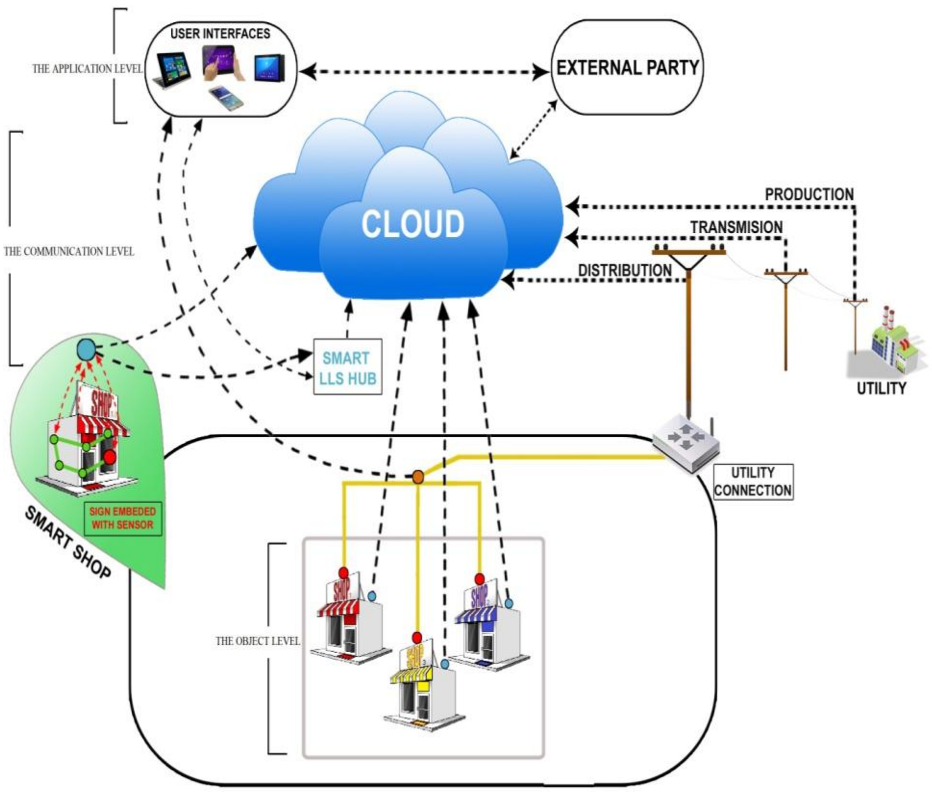

Fig. 5. IoT framework comprising the required components for smart LLs.

IV. Conclusions and future work

Through both automation and augmentation, IoT technologies promise to improve people's lives. This paper addresses the vision where traditional LLs can move towards smart LLs by the proper employment of IoT technologies. As in similar contexts (e.g. smart cities and buildings), shopping centers can be equipped with certain elements of IoT in order to cope with the vast technological advancements experienced across many sectors. Challenges such as big data provision (Zaslavsky, Perera, & Georgakopoulos, 2013), reliability, privacy, and security (Iyer, 2011) remain obstacles to achieving the desired advancements. The main contribution of this paper is the IoT-based three-levels framework, which combines different components from the IoT literature. This integral IoT framework is specific to smart LLs, with carful consideration given to the three levels (i.e. the object, the communication and the application). This framework serves as a solid base for future developers of IoT-based smart LL solutions.

It is recommended that shop owners, council members, and application developers work collaboratively to identify the system requirements, including the important elements discussed in this paper and provide them in a timely manner to improve the Lalor shopping center LLs. Relevant regulations should also be put in place to provide customers with more effective and efficient experiences. Future research directions could shed light on energy consumption issues for IoT technologies and address the challenges of big data, reliability, privacy and security for such emerging systems. Another future research direction could focus on the issue of multilingualism, especially in contexts where people come from diverse linguistic backgrounds. Smart LLs applications should consider different languages to benefit a wider range of involved society. The selection of additional languages may consider those highly used within the surroundings suburbs.

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