Design and implementation of a dynamic platform CMS via OCC technology

Sahar Yousfi[a], Emna Ammar Elhadjamor[a,b] , Farouk Cherif[a]

[a] *Higher Institute of Applied Sciences and Technology of Sousse, Tunisia*
[b] *RIADI Laboratory-ENSI, Manouba University, Tunisia*

ABSTRACT

Over the past few years, the volume of digital content has grown exponentially and the emergence of wireless and light communication technologies has attracted increased attention. Furthermore, organizations have felt the need to use powerful platforms to manage this huge amount of content robustly and reliably to provide more and more value-added services to target consumers. The objective of this work is to realize a dynamic platform for CMS media content management via OCC technology as well as an integration of indoor mapping that allows the diffusion and interior positioning in the spaces. Also the design and implementation of a mobile application that allows smartphone users in the spaces to receive the desired media content and to be guided.

KEYWORDS

Content Management System, Light Fidelity, Optical Camera Communication, Indoor Mapping

1 Introduction

With the emergence of the internet and the evolution of wireless technologies, the marketing challenges to attract the maximum number of target customers have been reinforced by innovative technologies in various sectors. In this setting, light communication technology has gained significant and solid interest, both in the research and practice community. These technologies bring richness in applications with new functionalities being deployed in arenas, museums, and shopping malls, etc. Imagine a world where the light bulbs in homes can connect to the Internet without bandwidth by simply flipping a switch. This is the magic of light and wireless communication technologies such as light fidelity (LIFI) and optical camera communication (OCC).

With the data revolution, new opportunities for the integration of Light communication technologies with OCC are expanding the interest of researchers and decision-makers. By using its broadest available spectrum, light can be used to deliver greater amounts of data at faster speeds and with greater security. Moreover, Content Management System (CMS) gained a presence in the market due to the information management benefits they offer, thus providing a new landscape in application development. Almost all modern platforms aim at providing their end-users with information such as discount coupons, promotions related to target products, location-based support, and route planning within their commercial spaces or others.

Indeed, nowadays, we notice large premises (spaces, shopping malls, arenas, museums, showrooms, etc.) that extend over several hectares of surface and often over several floors. Visitors to these spaces can find themselves lost, struggling to locate and wait for their destination.

Currently, applications based on this technology allow for the static display of utility or marketing content according to the identifiers received from compatible lamps.

To improve the user experience, this project consists of implementing an OCC technology that aims to distribute marketing content and geolocated utilities and to facilitate guidance within interspaces. The achievement of the entire system needs, first, developing a CMS platform for the management of all the media content that will be displayed on the screens of the mobile users, and integrating the indoor mapping of each space. The other part of the project is developing a mobile application that allows users to receive and view details of the marketing content. It also makes them benefit from the indoor mapping and all the offered directions.

The remainder of this paper is organized as follows. Section 2 introduces the basic concepts like LIFI and OCC. Section 3 and 4 give an overview of the proposed solution and our main contributions. The last section gives a brief conclusion.

2 Background

This section presents the main concepts related to our research.

2.1 Content Management System (CMS)

A CMS is a flexible and highly dynamic application for managing information (e.g. documents or events) and publishing them. According to Krouska et al. [1]. CMS is a system that allows the creation and modification of digital content, which includes files, images, electronic documents, audio files, and many other files, in real-time or as needed. To develop a web application based on a CMS it is necessary to start by identifying the needs of the application (types of content, visual aspect) and then develop modules allowing the CMS to integrate specific functionalities adapted to the business needs.

The idea of implementing a CMS is basically to offer specially-built areas like shopping centers, museums a practical resource that helps publish the desired utility contents to the visitors. So they can create and manage media content directly through an easy-to-access, understand, and use interface. There is no need for developers or coding experts to perform the desired actions. With simple and well-guided clicks, CMS users become able to manage and publish their content to the target.

Figure 1 illustrates the functioning of CMS.

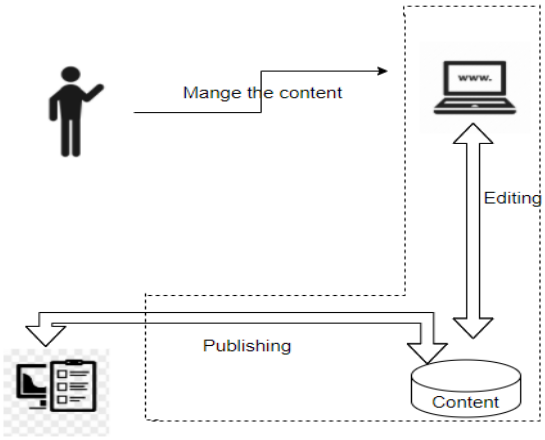

Figure 1. Content Management System

2.2 NoSQL database

With the explosion of the size of the data to be managed, traditional databases are not able to provide a satisfactory response time. The concept Not only Structured Query Language (NoSQL) presents a means of handling poorly structured data. NoSQL database was designed to overcome the limitations of relational databases. Compared with relational databases, NoSQL systems are more flexible, scalable, and get more performance. There are various categories of NoSQL databases such as:

– A key-value data system allows the user to store data in a schema-less manner,

– Column-oriented databases where the number of columns can vary from one record to another, which avoids finding columns with null values.

– Graph databases are databases that store data in the form of a graph.

– Document-oriented databases refer to databases that store their data in the form of documents. In this work, we are interested in this category. Document systems offer great performance and horizontal scalability options. Documents-oriented databases are somewhat similar to records in relational databases, but they are much more flexible since they are schema-less. Documents in the database are addressed using a unique key that represents that document. These keys may be a simple string or a string that refers to URI or path.

2.3 Light Fidelity technology

LIFI is a high-speed wireless communication that belongs to the category Optical wireless communication (OWC) technology. The data transmission is done through Light Emitting Diode (LED) bulbs with varying intensities. Depending on this variation, the communication is done digitally. LiFi can be deployed in a variety of environments, both business, and home, including smart offices, smart transportation, industry 4.0, shopping malls, etc.

This technology eliminates the adverse health effects of using electromagnetic waves. Since light cannot be seen, data cannot be hacked and therefore data transmission is secure. The data is usually expressed in terms of gigabytes per second [2].

LiFi is used to send content and contextual services to cell phones, it is the low-speed version (OCC). This variant allows the transmission of small amounts of information in an extremely precise perimeter. We can determine a mobile device's location to within a few centimeters of an employee, citizen, or customer. And, if desired, provide him with ultra-contextual information about devices through the use of LED lights.

A comparison between LiFi and WiFi technology [2] is presented in table 1:

Table 1. A comparison between Li-Fi and Wi-Fi

Parameter	Li-Fi	Wi-Fi
Speed	1-3.5 Gbps	54-250 Mbps
Range	10 Meters	20-100 Meters
IEEE Standards	802.15.7	802.11b
Spectrum Range	100000 times than Wi-Fi	Radio spectrum Range
Network Topology	Point To Point	Point To Multipoint
Data Transfer Medium	Used light as a carrier	Use radio spectrum
Frequency Band	100 times of Tera Hz	2.4 GHz

2.4 Optical Camera Communication OCC

Nowadays, many radio frequency wireless applications are being substituted by optical wireless technologies. One of these emerging and promising technologies is Optical camera communication (OCC) [3].

OCC is a technology in which a camera image sensor is employed to receive data bits sent from a light source. The OCC technology is provided by Zero1, a technology company, which is the only one in the world to provide LIFI and OCC via smartphones. It is currently active in Europe. Zero.1 is a hardware and software provider specializing in camera-based communication OCC founded in 2016.

According to Chowdhury et al [3], OCC overcomes the limitations of Bluetooth and other existing RF technologies. Therefore, it can deliver secure, interference-free, and reliable communication to gather data from several LED sources. OCC-

based systems can deliver high-reliability communication for connectivity between the access network and the sensor/patch. Other significant advantages of OCC are its high signal-to-noise ratio (SNR) and stable communication over varying distances. Moreover, OCC offers high-performance characteristics, including an excellent signal-to-interference-plus-noise ratio, high security, low interference, and high stability concerning varying communication distances [4].

Figure 2 shows the working principal of OCC, in which in the transmitter side according to input data stream the LED driver modulates the LED light and in the receiver side mobile camera's image sensor can be used as detector. Then the received signal from sensor can be demodulate using signal and image processing algorithms and the output data can be extracted.

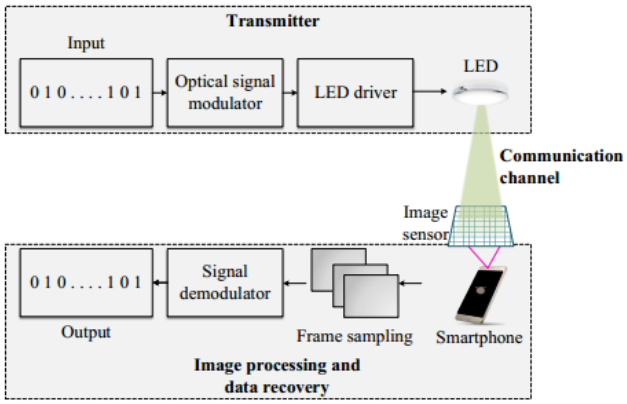

Figure 2. The schematic block diagram of an OCC system according to Hasan et al (2018)[4].

2.5 Indoor mapping: Mapwize

With an estimated 80% of our time spent indoors, it became necessary to allow people to easily find their way around and manage their building campus. This is where an indoor mapping solution has a role to play. MapWize is a company that allows developers of an indoor location application to translate architectural floor plans into a digital map. Not only do they convert the existing plans but also implement routing and specific points of interest. This eliminates the need for a specific developer team of the company or agency to develop this system as this is part of the service MapWize provides, according to Cardoen, et al (2019)[5] . Figure 3 illustrates the functioning of MapWize.

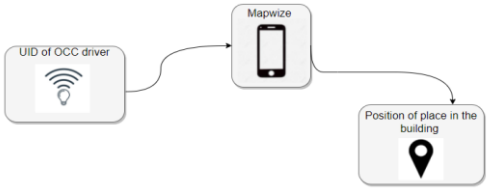

Figure 3. Illustration of MapWize

Based on the study of according to Cardoen, (2019), Table 2 provide a comparison of different services offering digital, interactive maps and wayfinding.

Table 2. A Comparison of different services providing digital, interactive maps and wayfinding [5]

	MapWize	MazeMap	Google Indoor Maps	MapsIndoors
Deployment	Cloud-based, on-premises	Cloud-based	Cloud-based	Cloud-based
Indoor Positioning Technology	WLAN, BLE (Bluetooth Low Energy) , sensors, OCC, LIFI	WLAN, BLE, sensors	WLAN	Beacons, WLAN, magnetic fields, lighting
Wayfinding	Yes, manual	Yes, manual	Yes, manual	Yes, manual
manual Interactive Editor CMS	Yes	No	Yes	Yes
Updates	Automated, real-time	Automated, real-time	Manual by email	Changes not implemented: routing, the layout of map, and colors
Analytics	Yes	Yes	by payment	Yes
Authentication Systems	Yes	Yes	No	Yes
Developer support	Barebones and UI SDK / API, open-source	SDK / API	API	SDK / data API
Additional features	Automated tasks using scripts, the autonomy of maps, offline-first approach	Visualization of alarms in rooms, navigation for blind and vision impaired , Outlook integration	Standard Google Maps Features	Automation and integration of legacy software: CRM, ERP

3 Contributions

This work consists of developing (1) a dynamic CMS (Content Management System) platform that manages the media content and the interior mapping of the space, (2) A mobile application to receive the media content managed by the CMS platform and to benefit from the interior mapping without loss of time or path.

This project is composed of 3 axes:

3.1 CMS platform

This first part focuses on the development of a web platform, which is a single-client platform for managing media content.
The client of this platform is the company Zero1, the technology company, which is the only one in the world to provide the OCC via smartphones.

The spaces open to the public: arena, stadium, museum, or a shopping mall, which aim to introduce this OCC technology and make a demo with their data will be considered as potential customers with at least one Workspace. Remember that a Workspace is an environment using the OCC technology. Each Workspace contains items corresponding to where the OCC lamps are placed. This platform allows the management of the client company (Zero1), and therefore to manage the media which can be of several types such as images, PDF, audio, video, and URL, and to publish its content that will be purchased on smartphones when detecting the light signal of the OCC lamp these lamps turn off and on several thousand times per second, which allows sending a binary signal that represents the Unique Identifier (UID) of this OCC lamp.

3.2 Integration of interior mapping: Mapwize

The main objective of this part is to allow the user to navigate the area using his smartphone, assisting him in finding and seeing his location inside the building as well as providing him with alternative paths.
The fastest way to integrate interior mapping in our application is to use Mapwize. Mapwize is an interior mapping platform that addresses large buildings and digitizes their architectural plans provided by the client to create interactive maps by giving the possibility to customize the graphic rendering, add points of interest and traffic rules.

For the web side, the integration of Mapwize with the CMS platform allows assigning to each Workspace its interior map that represents the building space and the places of items that are surfaced in this mapping.

And on the mobile side, Mapwize can be combined with OCC technology to manage the users of the user. An OCC lamp sends an invisible binary signal that can be read by smartphone cameras, and each camera and each lamp has a unique identifier that can only be read when the user is right underneath it, which allows getting an accurate position of the user. Then the user can consult from his smartphone his exact inner position thus to guide him.

3.3 Mobile axis

The third axis in our project is the mobile application that will be used by the visitors of the spaces using the OCC technology and to receive the utility and marketing contents provided and managed by the CMS platform. The moment the user's smartphone detects the light signal of an OCC it receives media content that has been assigned in the CMS platform to that particular lamp. In addition, using this mobile application, smartphone users can consult and view their internal position in the building map and choose the routes that suit them best. The mobile application was developed with the Xamarin platform.

4 Illustration

Figure 4 presents a schematic overview of the technologies used in our proposed solution.

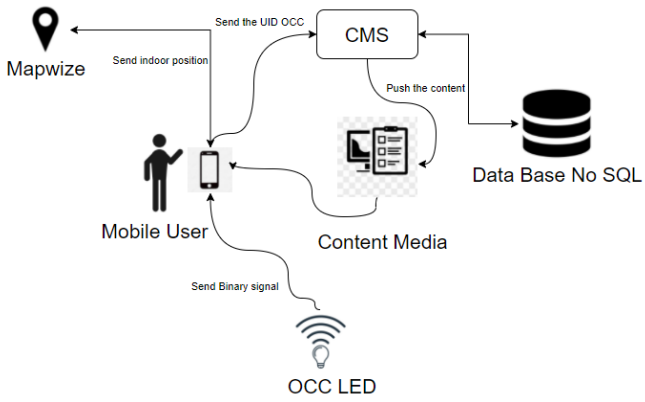

Figure 4. Our Proposed Solution

The analysis of an application always starts with the determination of the different actors by carrying out a study of the interaction of our system with its environment. An actor is an entity external to the system. It represents a person or another computer system that expects one or more services offered by an access interface. It interacts with the system by sending or receiving messages. It is useful, and even necessary, to remember that the CMS platform is a Single-Client platform. Its users are addressed to two types of roles which are :

- Administrator who is among those working in the company Zero1: He manages the client company.

- User: He is a simple user of the platform who can manage the utility and marketing contents of the Workspace and the internal map of the Workspace.

Of course, for the mobile application there is only one actor:

- The Smartphone user receives the media contents and interacts with the indoor mapping.

As we mentioned earlier, our solution must be able to realize a complete web and mobile platform for and mobile platform for

environments that use OCC technology and its visitors. The following list identifies the overall functional requirements:

- A web application that manages the media content and the interior mapping of the space (Named CMS).

- A mobile application to receive the media content managed by the CMS platform and to benefit from the interior mapping.

As an administrator of the platform he can:

- Authenticate

- Add users

- View and edit the general information of the client company.

- Edit the client company's solution

- Manage the client company's applications

- Manage the client company's partners

- Manage the client company's events

- Manage the client company's links

- Manage enterprise customer information

As a user of the CMS platform he can :

- Manage Workspaces

- Manage items in a workspace

- Manage the media content, which will be purchased in the Smartphones, specific to each item and their types

- Publish or hide the media content linked to the item: the publish mode allows the media content

- Assign the driver license and grant it to each Workspace to get the usable lamp identifiers

- Add the lamp indicators to each item

- Create the URL to access the inner map of the Workspace

- Access to the Mapwize map of the Workspace

- Assign the location of each item in the Mapwize map of the Workspace

- Access the exact location of the item on the Workspace

As a mobile user:

- Receive marketing content upon detection of an OCC lamp previously managed its content (supposedly uploaded) in the CMS platform

- See its current position in the map inside the Workspace where it is located

- See the position of a destination in the inner map of the Workspace.

- Find out the exact path on the inner map leading to its target whatever its current position is

Figure 5 explains the main activities of the mobile user.

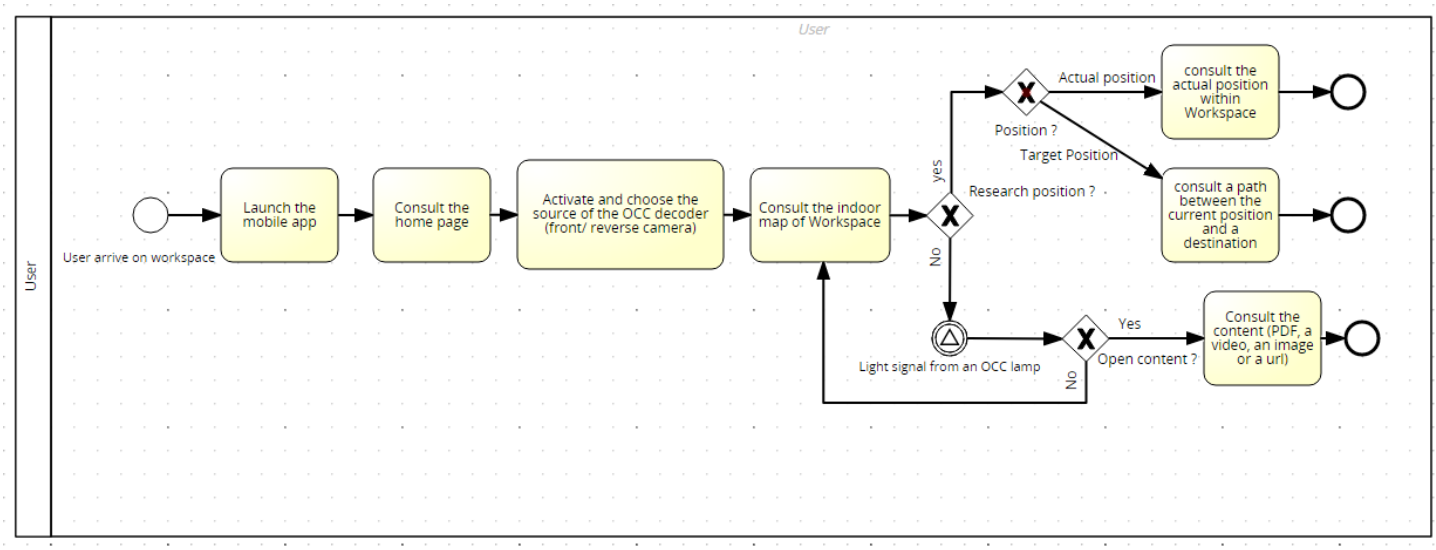

Figure 5. The main process of the proposed solution

5 Conclusion

New and emerging technologies and new services are transforming our daily lives. In this context, this work allows the management of media content and associate them with OCC lamps and to assign the interior maps of the spaces so that the user of our mobile application to receive the new services and information provided in these contents while specifying the user's contents sent while specifying his location and his path to follow in that space.

Following this work, several perspectives can be considered. among the most exhilarating persuasions, we can enhance the choice of the itinerary by taking into consideration the traffic of the public in the inner space. Also, it is possible to find the optimal route using graph theory or Markov chains to save more time if the customer is in a hurry and wants to optimize his path.

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REFERENCES

[1] Krouska, Akrivi, Christos Troussas, and Maria Virvou. "Comparing LMS and CMS platforms supporting social e-learning in higher education." 2017 8th International Conference on Information, Intelligence, Systems & Applications (IISA). IEEE, 2017.

[2] Jadhav, Akshata, Prajakta Satarkar, and Nimisha Deval. "Performance Improvement Using Light Fidelity Network." (2020).

[3] Chowdhury, Mostafa Zaman, et al. "A new 5g ehealth architecture based on optical camera communication: An overview, prospects, and applications." IEEE Consumer Electronics Magazine 9.6 (2020): 23-33.

[4] Hasan, Moh, et al. "Performance analysis and improvement of optical camera communication." Applied Sciences 8.12 (2018): 2527..

[5] Cardoen, Joachim. "Indoor location in complex multi-floor hospital environments." (2019).