

SMART HOME BASED ON LI-FI TECHNOLOGY

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Abstract—Smart homes are among the most interesting applications of Internet of Things that enhance the quality of human life and brings more comfort, savings, convenience and peace of mind. In this paper, we propose a smart home system that uses Li-Fi technology as medium of communication between all the connected devices and uses a video surveillance system based on Wireless Visual Sensor Network. Li-Fi is a high-speed bi-directional fully connected technology that provides transmission of data through illumination using LED light bulb. The use of such technology in our proposed system ensures a high level of security, high speed of data transmission, low energy consumption and more convenience.

Keywords— *Elderly care; Internet of things; Light-Fidelity; Smart home; Wireless Sensor Networks; Wireless Visual Sensor Networks.*

I. INTRODUCTION

Recent advances in wireless communications, cloud computing, Big Data and the availability of inexpensive wireless sensors, have led to the rapid development of the Internet of Things (IoT).

Smart home, also referred to as home automation or eHome, is among the most interesting applications of IoT that makes human life more comfortable by providing connectivity and control of every digital devices in home, such as air conditioning, heating, ventilation, lighting and security systems, regardless of time and place. Smart home brings significant advantages to the human daily life such as:

- *Comfort and convenience*: by controlling the home from anywhere and at any time, and by setting the home devices to specific needs such as adapting rooms heating and air conditioner to the preferences of users or according to the weather changes.
- *Accessibility*: by enabling people with disabilities, or special needs to live more independently by using assistive or adaptive technologies, for example, a person who cannot see can use voice-

activated interface to control his connected devices.

- *Communication between the devices at home*: by connecting devices, appliances and sensors in the network, they able to communicate with each other, and can be controlled remotely.
- *Energy efficiency*: By providing the flexibility of monitoring electricity consumption to consumers[1] and permitting the system to switch on or off appliances when they are not needed in order to save electricity. Otherwise, by using renewable energy to produce its own energy, such as installing photovoltaic systems on the home roof.
- *Security*: By installing cameras, motion detectors, smoke and fire detectors, locks, etc., the user can monitor and view his home no matter where he is and can be notified immediately if something is out of the ordinary regarding the home's condition.

However, smart home application is facing a few challenges, which need to be overcome such as *interoperability, cyber security / privacy* and the *interference issue* caused by the radio waves of Radio Frequency (RF) technologies (such as WiFi) that interfere with other electronics in the home, leading to slowing its functionality or even stop it.

Many applications for smart home have been envisaged like smart lighting, security systems, smart appliances, elderly care and kindergartens. Most of these applications use standards of communication such as Bluetooth, Zigbee, Z-wave and WiFi to transmit the collected data from the home environment to a Base Station (BS) called home sink or home hub.

In this paper, we propose a smart home system that uses Light-Fidelity (Li-Fi) technology as medium of

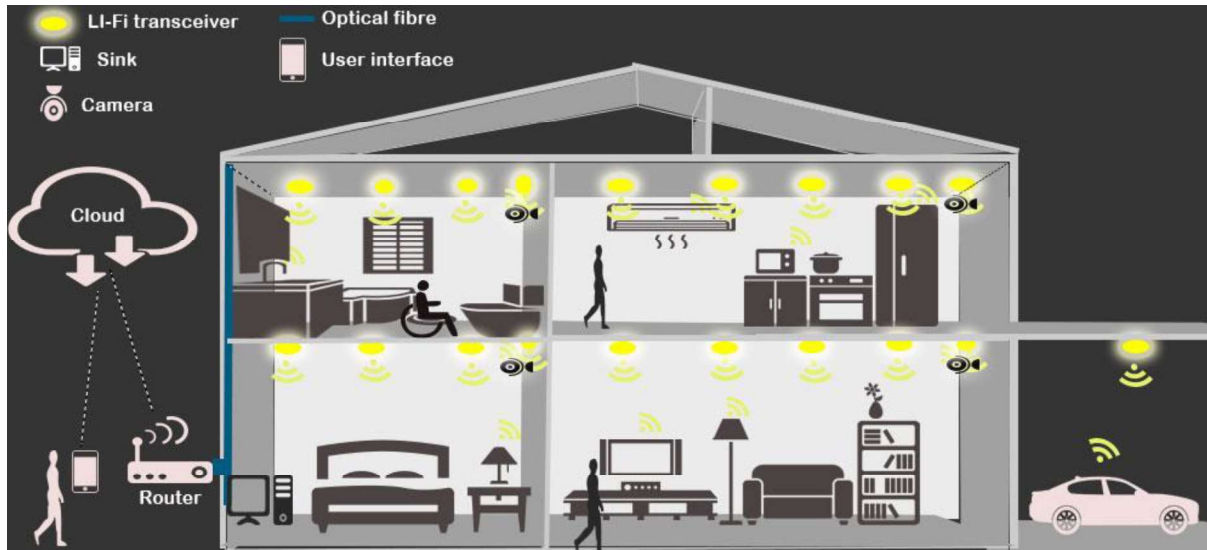


Fig. 1. Our Smart home system based on Li-Fi technology

communication between all the connected devices and uses a video surveillance system based on Wireless Visual Sensor Network (WVSN).

The rest of the paper is organized as follows: we start in section 2 with an overview of the methods and the tools used in the proposed system, followed by a use case of the system in Section 3. Then the conclusions are presented in section 4.

II. OUR PROPOSED SYSTEM

In this section, we will present our proposed smart home system that uses Li-Fi technology for communication between the connected devices, and uses WVSN as system for surveillance.

Our proposed system concept is shown in Fig.1, where all devices are connected to each other and to the internet via Li-Fi and controlled by a user interface from anywhere and at any time using cloud computing.

Li-Fi is a high-speed bi-directional fully connected Visual Light Communication (VLC) technology that was proposed by the German physicist Harald Haas. It uses visible light with wavelength in the range of 380 nm–750 nm [2] in order to provide transmission of data through a very high switching ON and OFF speed of LED light bulb illumination that cannot be tracked by the human eye.

The idea behind choosing Li-Fi technology rather than traditional RF technologies is due to its several advantages [3] [4] [5] that are summarized in Fig.2.

One of the best advantages of Li-Fi is that it can be used to provide both lighting and information in the same time. Li-Fi is also characterized by its higher bandwidth, which makes it more than sufficient for transmitting all types of data (scalar, video, etc.) in a very short time.

Unlike Wi-Fi technology, Li-Fi cannot travel through non-transparent material such as walls, which will provide more secure data transfer as it confines the data transmission to one area and it do not have any interference issue. The use of LED light in Li-Fi, makes it more suitable for indoor applications because it is cheaper and safer for eyes.

As a security system in our proposed smart home, we suggest the use of a WVSN that consist of a large number of tiny visual sensor nodes called camera nodes, which integrate an image sensor, an embedded processor, and a wireless transceiver[6]. These nodes can collect image / video data from a region of interest, process it collaboratively, and transmit the useful information to the BS.

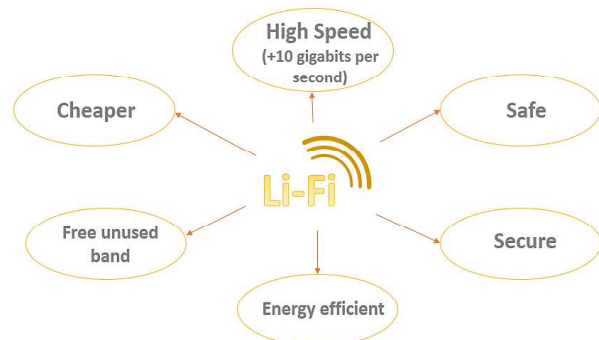


Fig. 2. Li-Fi advantages

The extension or the reparation of this system is easier because new cables installation are not needed to add new cameras in the network[7].

In this system, camera nodes will be able to communicate with other devices to complete a specific task. As a use case, we take elderly care.

III. USE CASE: ELDERLY CARE

Due to chronic illness and declining health that affect most of older people, performing everyday tasks becomes more challenging and home environment becomes a place with a high-risk for falls[8].

Thus, smart home technology could be an alternative to minimize risks resulting from aging or disabilities and to facilitate old people independence and activity[9].

In our proposed system, camera nodes will be able to detect and monitor older person activities and collect other information such as walking speed, posture, balance, etc., and send the collected data to a repository in the BS, which will be then stored in the cloud in order to be accessed by his doctor or therapist and by the family. If something is out of the ordinary regarding the older person activity, a notification will be sent automatically to the concerned persons.

Other sensors and devices can communicate with the camera nodes to facilitate older people daily life, by turning on/off water or lights automatically, adjusting room temperature according to the preferences of the old person, reminding him to take medicine in time and if he forgets, his family will be alerted, etc.

In addition, the older person can have real-time interactions with his doctor or his rehabilitation center in order to have a consultation or a training session remotely by using interactive telemedicine services.

Due to Li-Fi advantages presented in Fig.2 and the use of WWSN, our system will provide a cheap, fast, secure and energy efficient connected system, that enhances the quality of human life in a more comfortable home.

IV. CONCLUSION

In this paper, a cheap, fast, secure, and energy efficient smart home system based on Li-Fi technology as medium of communication and wireless visual sensor network as video surveillance system is presented. To evaluate the utility and the advantage of this system, an elderly care use case is discussed.

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