Location-aware application with Li-Fi

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Abstract

Li-Fi is a technology that uses visible light from a Light Emitter Diode (LED) to transmit high speed data to a photo detector, which is connected to a smartphone or tablet. Location awareness refers to devices that can passively or actively determine their location with respect to a well-known location wireless communications device. In this paper we describe a Li-Fi based application, in which a smart phone or tablet with a light sensor and within the range of a Li-Fi lamplight, immediately trigger events like displaying a picture, accessing a Web page, or playing a video.

Keywords: LED; Li-Fi; Location-awareness; Android

1. Introduction

Li-Fi is a term that was coined by Harald Haas [1, 2] and is a form of visible light communication (VLC) and a subset of optical wireless communications (OWC). This OWC technology uses light from light-emitting diodes (LEDs) as a medium to deliver networked, mobile, high-speed communication in a similar manner to Wi-Fi [3]. Visible light communications (VLC) works by switching the current to the LEDs off and on at a very high rate, too quick to be noticed by the human eye. Although the light waves cannot penetrate walls, it is more secure from hacking, relative to Wi-Fi. Both Wi-Fi and Li-Fi transmit data over the electromagnetic spectrum, but whereas Wi-Fi is close to full capacity, Li-Fi has almost no limitations on capacity. The visible light spectrum is 10,000 times larger than the entire radio frequency spectrum [4]. Researchers have reached data rates of over 10 Gbps [5].

Location awareness refers to devices that can passively or actively determine their location with respect to a well-known location wireless communications device. Location awareness enables new applications for ubiquitous computing systems and mobile phones or tablets. Such applications include the automatic reconfiguration of a computing device to suit the location in which it is currently being used. Examples include publishing a user's location to appropriate members of a social network, and allowing retailers to publish special offers to potential customers who are near to the retailers [6].

This paper describes a Li-Fi based application, in which a smart phone or tablet with a light sensor and within the range of a Li-Fi lamplight, immediately trigger events like displaying a picture, accessing a Web page, or playing a video.

The remainder of this paper is organized as follows: Section 2 presents a summary of works related to location-aware services. Section 3 describes the design of our location-aware application with Li-Fi lamps and an Android tablet with a light sensor. Section 4 shows the results of the implementation. Our conclusions and future work are presented in Section 5.

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2. Related Work

Several research works on VLC technologies have been proposed, they are described in the following.

2.1. LEDs--leads-you-right-to-a-discount

In [7, 8] ByteLight an English Company focused on using LEDs to provide high-speed data communications—the technology referred to as Li-Fi, felt their technology was better suited to helping people find their way around large indoor spaces. The idea was the following: suppose you are in a department store that has replaced a number of its traditional lightbulbs with ByteLights. The lights, flickering faster than the eye can see, would emit a signal to passing smart phones. Your phone would read the signal through its camera, which would direct the smart phone (Fig. 1), to pull up a deal offering a discount on a product on a nearby rack.

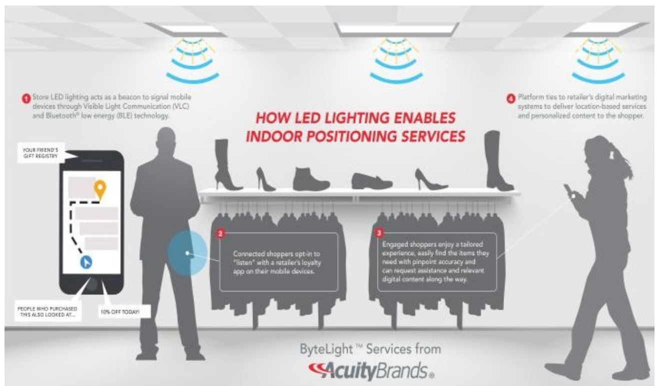

Fig. 1. A ByteLight's LED bulbs system.

2.2. Philips shopping assistant with LEDs and Smart Phone

In [9] Phillips Lighting showed a LED-based indoor location detection technology. The system is similar to ByteLight, in terms o f location-determination technology that relies on one-way communication between networked LED-based luminaires and customers' smartphones. In both cases the customer requires however, to download an app to utilize the technology. The communication link from luminaires to the smartphone would deliver the location data and offers. Fig. 2.

Fig. 1. Philips Lighting LED-based indoor location detection technology.

2.3. Oledcomm Li-Fi.

Oledcomm [10] is a French Company that produces tiny routers that allow LED lamps to transmit data using visible LED light, see Fig. 3. It also sells kits to experiment with the Li-Fi technology.

Fig. 1. Oledcomm Li-Fi.

3. A location-aware Li-Fi application

In the following we develop a location-aware Li-Fi application in which when an Android phone or tablet with a light sensor, is within the range of a Li-Fi lamplight, it will immediately display a picture, access a Web page, or play a video, depending of the ID code of the lamplight. In order to do that, we used the Oledcomm GEOLiFi XS Kit [11]. This kit contains: a) 3 GEOLiFi LED lamps, b) 1 GEOLiFi Android Tablet with an embedded sensor light; c) 1 extra GEOLiFi Dongle to be used with a Smartphone; and d) 1 GEOLiFi SDK Library. See Fig. 4.

Fig. 4. The Oledcomm GEOLiFi XS Kit.

3.1. Displaying a Picture with LiFi

The GEOLiFi SDK Library has a small tutorial of how to use the Oledcomm GEOLiFi API. We begin loading the last version of Java SDK and Android Studio. After that we create a new Android application specifying the project and packages names with (in our case), mínimum SDK 8, target SDK (API 19) and compiling with SDK 20. The most important part is in the MainActivity class in the *LiFiLocation ()* method, Fig. 5:

```
LiFiLibDemoActivity.java ×   AndroidManifest.xml ×   main.xml ×
This file is indented with tabs instead of 4 spaces

    LiFiLocation position = new LiFiLocation() {

        @Override
        public void onLocationSuccess(String value) {
            // TODO Auto-generated method stub

            // the tag ID and current light intensity are received in this
            // value, perform your UI operations based on this
            text1.setText(value);
```

Fig. 5. The LiFiLocation () method.

This method is used for retrieving geolocation of a phone or tablet receiving data from a lamp Li-Fi. When this happens the corresponding ID lamp will be available. In our case, the Id of every one of the three lamps were:

a) Lamp 1: 0xd5d5
b) Lamp 2: 0x6390
c) Lamp 3: 0x6e71

Having known the Ids of the three lamps, we simply use the first ID (0xd5d5) for displaying a picture in the tablet whith the follwing java code, Fig. 6:

```
    if (value.equals("0xd5d5")) {
//      text1.setText(value  + "codigo lamp 1 0xd5d5, codigo lamp 1 0xd5d5,

        ImageView img;
        img = (ImageView) findViewById(R.id.imageView1);
        img.setImageResource(R.drawable.li_fi_tech);
```

Fig. 6. Code for displaying a picture when the tablet receives the ligth code from lamp1.

Of course, the *li_fi_Tech.png* picture must be already available in the *res --> drawable directory*.

3.2. Displaying a Web page with Li-Fi

The following java code allows access a Web page when the tablet receives the light code (0x6390) from lamp 2. Fig. 7.

```
} else if (value.equals("0x6390")) {
        text1.setText(value + "código lamp 2 0x6390, codigo lamp 2 0x6390,

        WebView webView;
        String home="http://www.oledcomm.com";
        webView = (WebView) findViewById(R.id.webView);
        webView.loadUrl(home);
```

Fig. 7. Accessing a Web page when a tablet receives the light code from lamp 2.

3.3. Displaying a video with Li-Fi

To display a video using Li-Fi, we use the light code *0x6e71* and the following java code, Fig. 8. The *video.mp4* must be already stored in this case, in the res→raw directory.

```
    } else if (value.equals("0x6e71")) {
            text1.setText(value + "código lamp 3 0x6e71, codigo lamp 3 0x6e71, codigo lamp 3 0x6e71");

            getWindow().setFormat(PixelFormat.UNKNOWN);
            VideoView mVideoView;
            mVideoView = (VideoView) findViewById(R.id.surface_view);
            String uriPath ="android.resource://com.example.lifilibrarydemo/"+ R.raw.video;
            Uri uri2=Uri.parse(uriPath);
            mVideoView.setVideoURI(uri2);
            mVideoView.setVideoPath("android.resource://com.example.lifilibrarydemo/"+ R.raw.video);
            mVideoView.setVideoPath("http://www.ebookfrenzy.com/android_book/movie.mp4");
            mVideoView.start();
            mVideoView.requestFocus();
} else {

        text1.setText("no se pudo leer codigo lamp 3, no se pudo leer codigo lamp 3  " + value);
    }
```

Fig. 8. Displaying a video with Li-Fi.

4. Experiments and Results

For the experiments we use as was mentioned an Oledcomm GEOLiFi XS Kit with an Android OS 4.2.4 tablet (Fig. 9), thus as another Toshiba tablet AT100 with Android OS 3.1, but with a light sensor connected into the airphone jack (Fig. 10).

Fig. 9. GeoLiFi Kit Android Tablet 4.2.4 and three Li-Fi lamps.

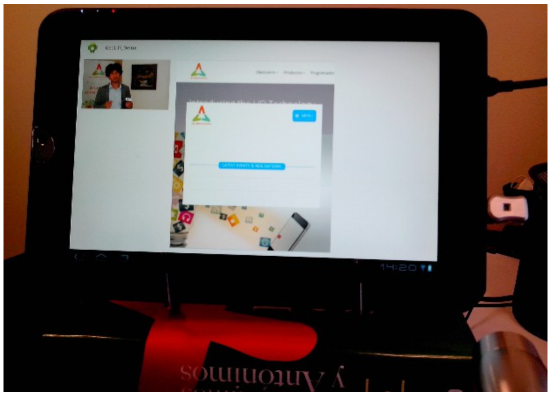

Fig. 10. Tablet with attached Li-Fi sensor into the airphone jack.

Figures 10 and 11 shown the correspondig picture, Web page (overlaping the picture) and the video. In figure 11 it can also be noticed the embedded Li-Fi sensor (down to the right from the camera lens).

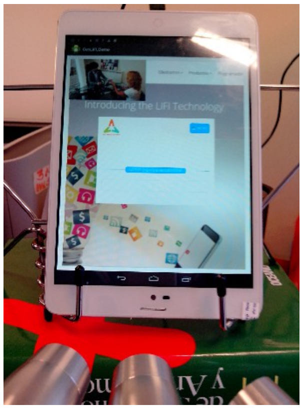

Fig. 11. Tablet with Li-Fi sensor embedded.

4.1. Discussion of results

A location-aware Li-Fi application was developed using three Li-Fi lamps and Android tablets with a Li-Fi sensor. When the tablet was within the range of a Li-Fi lamplight, the light sensor read the light code of the lamp under test and triggered events like displaying a picture, accessing a Web page, or playing a video, according to the respective light code. Both tablets worked fine with the Li-Fi lamps. However the tablet with the attached Li-Fi sensor was less sensible to the Li-Fi light than the Oledcomm tablet.

5. Conclusions

In this paper we have discussed recent developments in the area of location aware applications with Li-Fi. These developments exploit the opportunity of piggybacking location aware data over LED lamps. Our focus was on showing how to develop a simple application to test this technology. The results obtained showed that indeed Li-Fi transmit data via the light from the lamps.

5.1. Future work

This application may still be expanded beyond the actual state, making it more useful by developing for example, a mobile application to guide people through large indoor spaces like museums and stores.

Acknowledgements

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