Lumino: Location Based Data Ingestion using Li-Fi

Sharwari Phadnis
San Jose State University
San Jose, CA
sharwari.phadnis@sjsu.edu

Aakash Alurkar
San Jose State University
San Jose, CA
aakash.alurkar@sjsu.edu

Rajas Tulpule
San Jose State University
San Jose, CA
rajasrajiv.tulpule@sjsu.edu

Aniket Deshpande
San Jose State University
San Jose, CA
aniket.deshpande@sjsu.edu

***Abstract* — In this report, we propose a system which contains a combination of multiple Light emitting diode and a photovoltaic cell which will be used to transmit and receive data respectively. As Li-Fi works in light spectrum bandwidth is greater and the speeds is much larger. Our proposed system aims to send data such as music(sound) through the light spectrum. Our first use case is focussed on creating a *Sound Guide* for the visually impaired people, by leveraging Li-Fi technology we have come up with a solution that is cost-effective, pollution-free, indigenous and resource-oriented. The second use case is focussed at enhancing the Museum/ Art gallery experience using Li-Fi technology.**

***Keywords* — Li-Fi, Visible Light Communication Systems, Light Emitting Diodes**

I. INTRODUCTION

LiFi is a wireless optical networking technology that uses light-emitting diodes for data transmission from one device to other. It is a Visible Light Communications (VLC) system. This technology employes visible light, like the bulbs we see in our daily life, to transmit data. It requires Li-Fi enabled LED light bulbs to transmit data, and a special receiver that can interpret that data. Li-Fi technology transfers data in a binary way using light emitted from a LED light bulb. This flickering on is translated into actual data by special photoreceivers that receive light signals.

Li-Fi can be considered as a light-based Wi-Fi. It uses light instead of radio waves to transmit information. Li-Fi is transmission of data using illumination i.e. sending data through an LED lamp that varies intensity of light faster than what human eye can perceive. The merits of Li-fi to that of Wi-fi are that High data transmission rates of up to 10 Gbps can be achieved, since light cannot penetrate walls, it provides privacy and security that Wi-Fi cannot, Li-Fi has low implementation and maintenance costs and unlike Wi-Fi, Li-Fi emits no radiation.

As the Light is available almost everywhere, Li-Fi technology can be leveraged in many applications. We are particularly interested in transmitting sound from one device to other using Li-fi technology as it can be used to solve a lot of daily problems and also enhance existing systems.

II. LITERATURE SURVEY

Light Fidelity Technology is a technology for wireless communication between devices that uses light to transmit data in a high speed. Currently Li-Fi technology can only be used with the help of LED lamps. The term was first introduced by Harald Hass during a 2011 TED Global talk in Edinburg. Li-Fi system is also capable of transmitting data high speeds over the visible light spectrum, ultraviolet and infrared radiation.

In terms of its end use the technology is similar to Wi-Fi. The key technical difference is that Wi-Fi uses radio frequency to transmit data. Using light to transmit data allows Li-Fi to offer several advantages like working across higher bandwidth, working in areas susceptible to electromagnetic interference (e.g. aircraft cabins, hospitals) and offering higher transmission speeds. The technology is actively being developed by several organizations across the globe.

In digital transmission system, data will be converted in to binary bits in the form of zeros and ones equivalent to ‘on’ and ‘off’ states. Visible light is an ultra fast electromagnetic wave with unlimited bandwidth to utilize. High speed switching of light can’t be detected by

human eyes but highly sensitive photodiodes can efficiently detect the modulation of light interact with the detectors.

The bandwidth of the visible light spectrum exceeds far more than radio waves being upto thousand times higher in it's bandwidth. Unlimited bandwidth makes it one of the most efficient solutions for data-intensive applications. Li-Fi technology is a fast data transfer, full duplex and bidirectional communication system capable of data rate up to 224 gigabits per second.

III. PROBLEM STATEMENTS

i. Smart Guide For The Visually Impaired using Li-Fi Technology:

Statistics show the number of visually impaired people are increasing and the trend is more as a person ages. In the times the person has to be dependent on others to guide them through their own home. There are certain corners and areas in the house which are dangerous if not known about, like the stairs or the kitchen top or sharp furniture.

These objects have to be fully informed to evade from harm being caused to the person. In the use case, let us look at Margaret an aged visually impaired person. Due to fear of not knowing what is where she is immobile. But our solution can change it all and give her independence. The solution incorporates the existing lights in the house, thus saving money and resources. The lights in the house will emit data in terms of sound waves about what likes ahead.

An example being, A light in the passageway will emit audio about which room is ahead or bathroom is at the right or be alert stairs are to the left. When Margaret comes near the light source her receiver will receive the audio signal and broadcast it to her about what lies ahead. As the intensity of the light is directly proportional to the volume of the sound she will also know how close or far she is to the room.

A similar transmitter had potential dangerous places like fireplace, kitchen top, oven, bathtub can save Margaret from injuries as she is aware of her surroundings. As the receiver is only a small LDR it can be fitted or even incorporated into a headband or a wearable device or headgear.

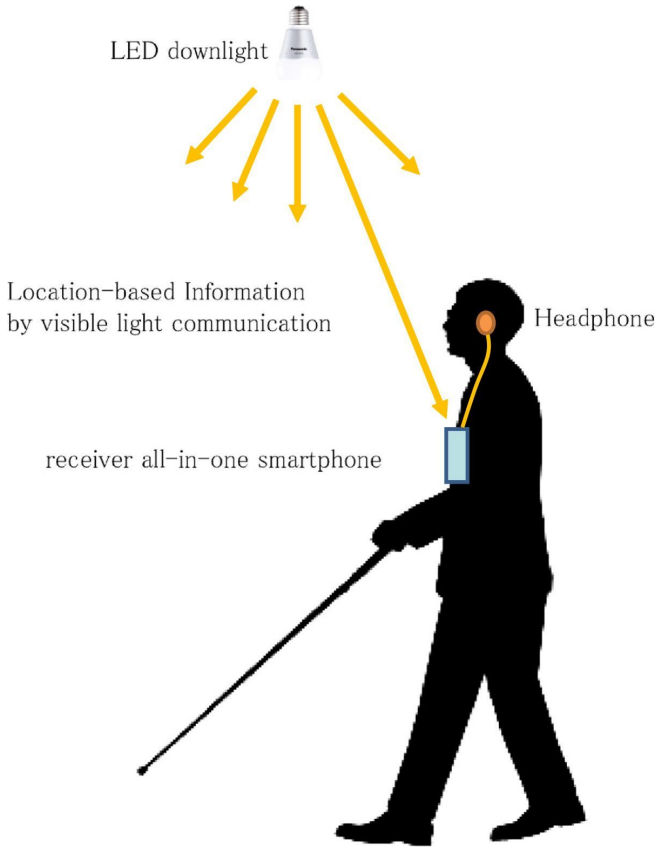

Fig. 1 Illustration for the Smart Guide system

ii. Museum/Art Gallery Enhanced Experience using Li-Fi Technology

This use case is specifically aimed to make the museum tour experience more fun and interactive with li-fi. The beauty of this technology is that it will replace the old and drab existing devices to deliver knowledge in the museum.

This technology can also be gelled with the new emerging ‘Augmented Reality Museums popping up in the world. Using Li-Fi in this use case can provide an energy efficient method for the museums to deliver information right at the user’s fingertips making museum visit a simple, approachable and fun experience rather than just listening to the information.

Fig.2 Existing Audio Guide Machines in Museum

For example, Mike and his team at the San Jose Art Museum are working towards transforming the museum tour experience. They want to serve each visitor with personally catered audio-visual information instead of plain old information boards at every exhibit.

This is where our state of the art Li-Fi application, Lumino, comes into the picture and serves Mike and his team with the perfect solution. Lumino is specifically aimed at making the museum tour experience highly interactive and fun with Li-Fi technology for first-time museum visitors, children and the elderly to have a superior museum experience.

The individual light fixtures at each exhibit deliver information about each exhibit. This positioning grid system with built-in Li-Fi in the light bulbs itself can deliver targeted information to the visitor. A visitor viewing a specific exhibit will just point the Li-Fi device provided by the museum at the light source and the audio-visual information about the exhibit will be displayed on the device.

Another place where John can use the lifi technology is at Art Gallery. Here every art or picture has a dedicated light source above the frame. The same light can be used to transmit data about the painting/art to the user. Nowadays nobody wants to read placards of the art gallery. Here John can just use his mobile device point it at the painting and get the description about the paining on his device.

Fig.3 Newer Li-Fi enabled Museum Guides

IV. SYSTEM DESIGN AND ARCHITECTURE

Generally, Li-Fi systems consists of a LED bulb on the sender side and one photo detector on the receiving side to receive the light signals. The streaming content say a video/audio file is applied as an input to a LED bulb, and the bulb acts as a router that delivers the streaming content to the special Li-Fi enabled receivers.

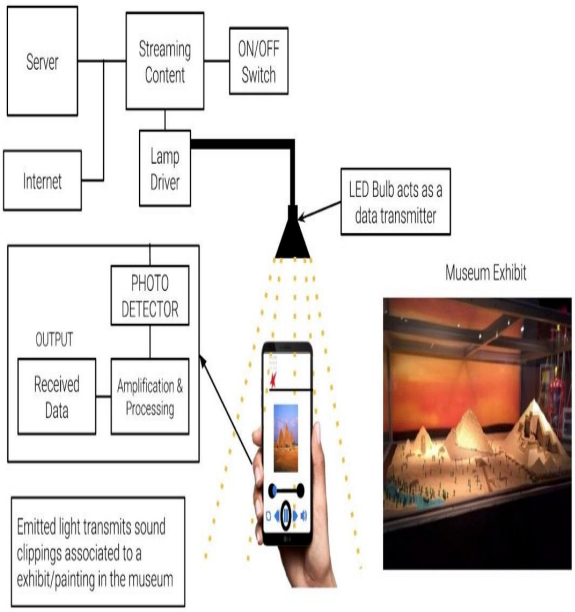

Fig.4 System Design Overview Diagram

The Li-fi based receiver involve a photo detector, and decoder that transmits the signals back into streaming

content at the receiver side. This triggers desired action in your smart device.

In our system, we have decided to use existing infrastructure to build a Li-Fi system instead of buying a commercially expensive product.

Our System consists of the following components:

- **Breadboard x2 LED x8**: To build our receiver side circuit and to avoid soldering.
- **Resister 100ohm x2**: To reduce current flow, adjust signal levels, to divide voltages that are required for our receiver circuit.
- **Wires** : For connection purposes
- **Battery pack**: To provide power/electricity to the circuit
- **Speaker**: To receive and play the Audio sent from a mobile or any other MP3 device.
- **Solar cell x1:** To receive the light signals from the LED light bulb.
- **Audio jack**: Used as a connector.

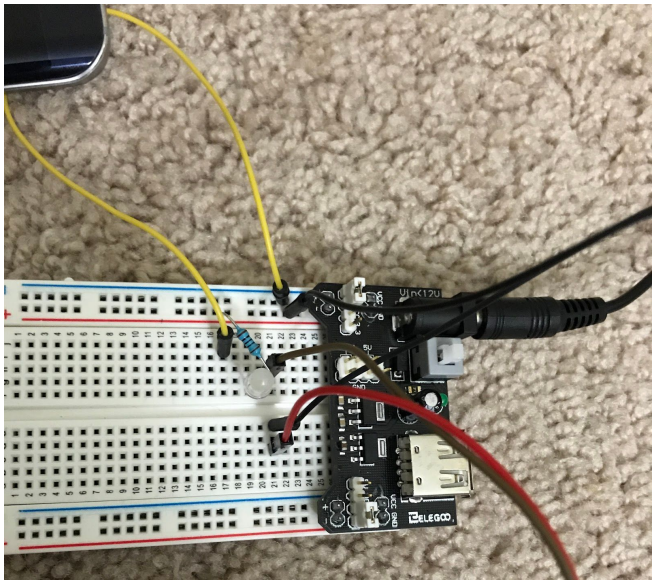

Fig.5 Sender Side Circuit

Fig.5 is our Sender side circuit that consists of a Power Supply module with an USB port and a converter. One LED light is connected to the power supply module via breadboard. The circuit is also equipped with wires and resistors to adjust the voltage given to the LED bulb.

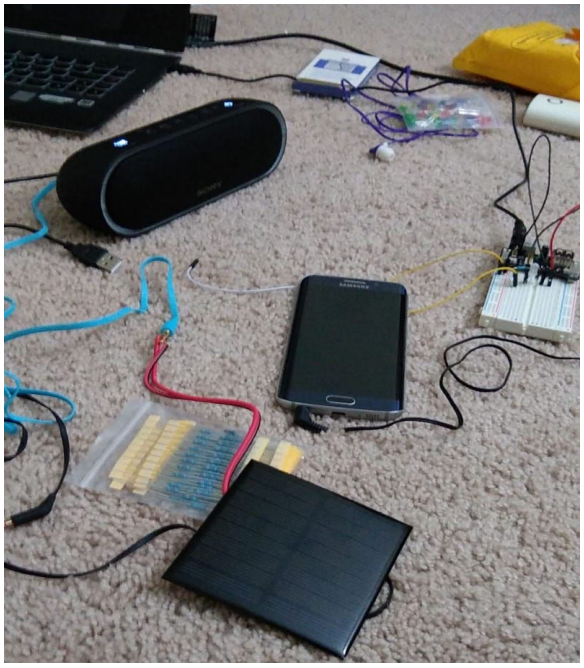

Fig.6 Lumino Complete Setup

The light signals sent by the LED bulb are then received at the Solar Panel, and are then forwarded to the speaker as data. Thus, by using minimal and existing infrastructure we have built a simple end to end Li-Fi system that caters to our use cases.

V. CONCLUSION AND FUTURE SCOPE

This system mainly focuses on creating cost-effective, reliable and simple solutions for guiding visually impaired people in their daily life and to enhance the normal Museum/Art gallery experience to a fun filling and interactive one.

The future scope of this project involves building navigation/tracking system, to charge mobile phones using Li-Fi technology. This can also be extended in commercial offices to receive faster data.

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