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Visible Light Communication Based Data Transfer System

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Abstract: Exploiting the increasingly wide use of Light Emitting Diode (LED) lighting, in this project, we present the phenomenon of using visible LED lights for data transfer and position determination. We have implemented the Visible Light Communication (VLC) system and evaluated it with a small-scale hardware. The basic idea is to use the existing lighting infrastructure and apply it for data transfer. Through the design of transmission and reception mechanism, we identify and tackle several technical challenges. We adopt the simple On-Off keying (OOK)for modulation in the transmitter section. The receiver section comprises of phototransistor and its amplification unit followed by Bluetooth module to ensure its connectivity to a smart phone. We believe that visible light based data transferi s promising to significantly improve the positioning accuracy,despite few open problems in practice.

Keywords: LED, OOK, VLC.

1. INTRODUCTION

We have been witnessing ever-increasing roll-out oflocation-based services, for which accurate location provisioning is a key. GPS has largely solved the problem for outdoor scenarios. However, accurate localization remains a grand challenge for indoor environments. Wi-Fi based indoor localization has attracted lots of research attentions, for the advantage of ease-use and low deployment cost by leveraging existing Wi-Fi infrastructure. Inspired by these favourable facts, VLC is designed to provide high-accuracy positioning in a low-cost and easy-to-use fashion. Light communication has several advantages: Light communication is visible (in contrast to invisible radio communication), so it is easy to determine who can listen to (orreceive) a message. Furthermore, light communication does not use electromagnetic waves, and there are environments or communities that may value this aspect. A side effectis that light communication does not require part of the(limited) radio spectrum and can therefore be seen as a suitable extension in bandwidth-limited scenarios, and (visible) light is present in many places, so there is the opportunity to combine light communication with lighting design to let Visible Light Communication (VLC) co-exist with (or even benefit from) the lighting setup present in many offices, homes, or institutions. It has three-fold implications. First, it reuses the existing lighting system for the data transmission purpose and can be gradually enabled. Second, VLC does not rely on any centralized localization service (e.g., a localization database in the Wi-Fibased solutions). Ideally, the system would be capable of "plug-and-play". Last but not least, VLC is able to yield high accuracy (sub-meter) localization. In fact, it is promising to achieve high accuracy by leveraging two advantages of the lighting system rather than other infrastructure-based systems (Wi-Fi based). The deployment of illumination lights is much (over one order of magnitude) denser than that of Wi-Fi access points (APs). For example, in an office floor, there are about 21 APs whereas over 300 light sources are deployed to cover the same space. Light sources, unlike Wi-Fi radio signals, are always visible.

2. VLC BACKGROUND

VLC means Visible Light Communication. It implies that, communication is taking place through visible lights such as LED. The main idea behind the project is the transfer of data using visible light sources. The data which is to be transmitted is modulated using different modulation schemes such as OOK, BFSK, BPSK etc. according to the design of hardware and convenience. Here we are using simple OOK in this project. The data is modulated properly and are transmitted along with the light. This is the basic platform of VLC. Any photo-detecting devices, such as photodiodes, phototransistors, etc, receive the transmitted data. The photo-detecting device receives the incoming light and produces an output current proportional to the intensity of incoming light. This current signal is demodulated back to the original message signal transmitted. Thus, receiver section is implemented.
Light Emitting Diode: LED is a simple semiconducting device. We envision that LED lighting will become the mainstream lighting technology in the near future for its several advantages. First, LED bulbs are much more energy efficient in comparison with the conventional compact fluorescent light (CFL) bulbs. Its lighting efficiency is almost constant (drop by less than 10% after70, 000 working hours) throughout the whole life span. Second, the lifetime is also much longer life span. Third, LED bulbs are free of mercury and thus more environmentally friendly. One drawback of current commodity LED bulbs is its higher production cost, which

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however is still a win considering the savings onthe energy expense.

Instantaneous On/Off: As a semiconductor device, LED possesses a feature – instantaneous on and off. Inother words, a LED bulb can be toggled within few microseconds.Our measurements using an oscilloscopeshow that the rising and falling edges of an ordinary LEDare about 4ms. Due to such property, Pulse Width Modulation (PWM) is the most widely used approach to dima LED bulb, i.e., frequently turning on/off the LED. InPWM, the brightness is determined by the duty cycle.Visible Light Communication (VLC): The instantaneous On/Off feature turns a LED lamp into an effectivetransmitter for VLC. LED bulbs can use various modulationschemes, such as On-Off keying (OOK), Variable Pulse-Position Modulation (VPPM), and Colour Shift Keying (CSK), to embed digital information in its light. VLChas been studied for years and was recently standardized in IEEE 802.15.7. One special mandatoryrequirement of VLC is to avoid the flickering problem, which is caused by the periodic changes in the instantaneousbrightness. It is reported that low frequency (less than 120Hz or 160Hz) flickers make people feeluncomfortable or even sick. Although there is no widelyaccepted criterion for the safe flicker frequency, it isgenerally thought that a frequency higher than 200 Hz issafe.An LED can emit as well as receive light andprovides therefore a simple building block for a Visible LightCommunication system.We describe a microcontroller-based system and its effectiveness in a testbed.LEDs provide an almost ideal platform for VLC. An LEDcan emit and receive light at the same time (with multiplexing).

3. HARDWARE IMPLEMENTATION

The VLC based positioning system consists of transmitter section, receiver section and Bluetooth connectivity for smart phones. The transmitter section consists of pre-programmed IC PIC16F887 for storing location or data and to perform modulation operation that is OOK. The modulated signal is fed into the LED (4Watt). The data is transmitted along with light. In the receiver section, the incoming light is captured using photoreceptor devices preferably a phototransistor. It converts the incoming light into electrical signals proportional to the intensity of light. The signal is amplified using a two-stage op-amp(LM358). The processed signal is given to the PIC-IC in the receiver side. The Bluetooth module is interfaced with the PIC-IC. The transmitted is now available in the smart phone after pairing with the Bluetooth device. The different building blocks areaddressed in the following subsections.

A) TRANSMITTER

A VLC Transmitter (emitter) is an electro-opticaltransducer device that transmits information using visiblelight signals over wireless transmission medium. VLCsystems have become a more viable technology for the futureof wireless data transmission, in large part due to thedevelopments in the area of solid-state lighting. The transmitter section consists of pre-programmed IC PIC16F887 for storing location or data and to perform modulation operation, which is OOK. The PIC-IC is selected other than conventional microcontrollers, because of its high driving current, stability and high efficiency. The programming used for PIC-IC is also simple and user-friendly.There are different switches given in-order to select the location. Switch-1 corresponds to the location-1, switch-2 corresponds to the location-2 and so on. The data corresponding to the switch selected will get modulated based on OOK and made ready for transmission. The modulated signal is fed into the LED (4Watt). The LED used here in this projectis 4-wattage LED, with heat sink built additionally for absorbing the heat produced. It is used with this design to facilitate an acceptable range for reception of the transmitted data. This LED can offer about 35cm range, which is appreciable. The range can be increased with the use of more intensity LED’s. The data is transmitted along with light.

I) BLOCK DIAGRAM

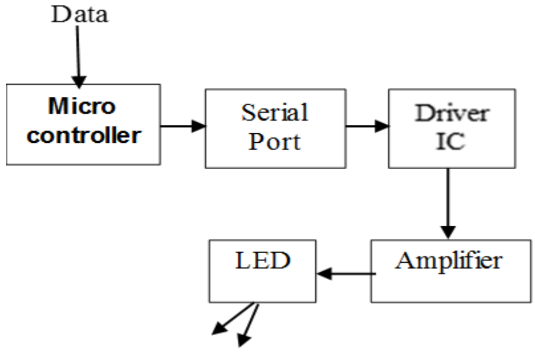

Figure 1. Conceptual Block of VLC - Transmitter

The block diagram of the transmitter section can be explained as the pre-stored data resides in the microcontroller(PIC-IC). The microcontroller contains the information about the location. The serial port of PIC-IC is used for interfacing.The microcontroller makes use of the serial communication port for transfer of data. The flow goes to the driver IC(ULN2004). This driver section passes the information to the amplifier section. The LED gets lighted up with the power supply unit and gets amplified. The data reaches the LED and gets transmitted.

II) ALGORITHM

The algorithm of the program used in PIC Microcontroller in the transmitter section is given below. This is the basic algorithm(transmitter) of the project. This is a basic concept of data transfer in VLC communication.

STEP1: START
STEP2: IF F1→1 SEND L1
ELSE
IF F2 →1 SEND L2
ELSE
IF F3→1 SEND L3
ELSE

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IF F4 1 SEND L4 →
STEP3: IF RST=1 GOTO STEP 2
STEP4: STOP

III) FLOW CHART

The flowchart of the algorithm (Transmitter) is given below. It gives a simple and basic idea about the flow of control of the system.

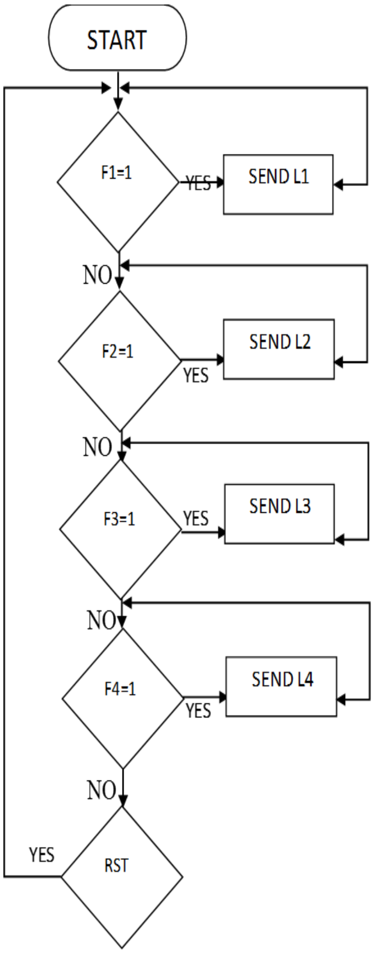

Figure2. Flowchart of Transmitter

IV) CIRCUIT DIAGRAM

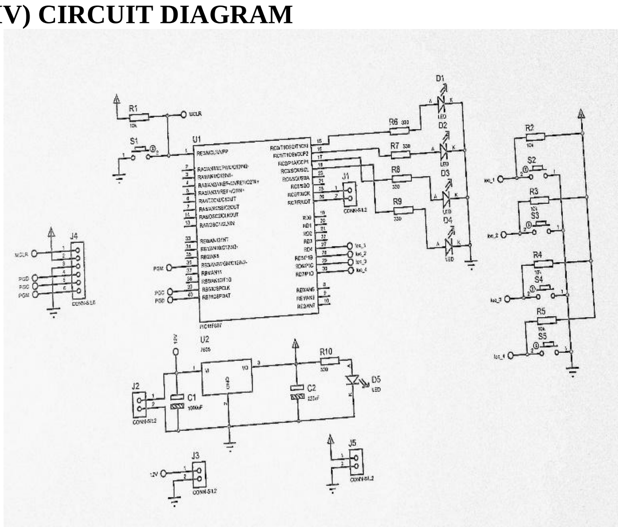

Figure 3. The VLC Transmitter

V) IMPLEMENTED TRANSMITTER SECTION

It consists of a PIC16F887 IC, the microcontroller used for pre-storing of information or location, 4 push button switches for different signal configuration means for selecting different location information to be transmitted, a driver IC(ULN2004), for driving the incoming signal into LED, an amplifier section for amplifying the incoming signal, a 4W LED for transmission of Data along with light, resistors, capacitors and regulator for regulation, LED gets illuminated by the power supply unit.

The data gets transmitted along with light, which completes the transmitter session.

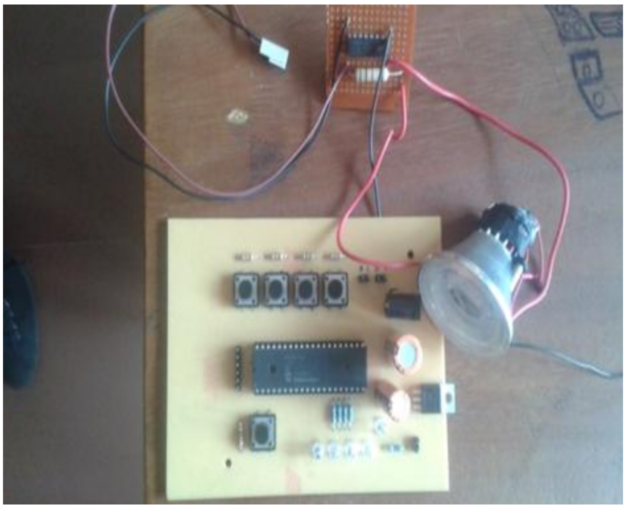

Figure 4. The Transmitter Section

B) RECEIVER

The VLC receiver is optic-electronic transducer thatreceives information, previously modulated in the visible light spectrum, and converts it into electrical signal capableof being processed by a demodulator-decoder. The correctdesign of this device is crucial to ensure good performance ofthe overall VLC system. Among other concerning factors arethe presence of low-level signals and high noise interference.The visible light pulses, originated at the system's emitter, are collected in a photo-detector; here phototransistor is used. Reversely biased phototransistor operates in the photoconductive mode, generating a current proportional to the collected light. This current has small values thus requiring pre-amplificationto convert it into a voltage. This preamplifier should have low-distortion.The signal is amplified using a two-stage op-amp (LM358). The processed signal is given to the PIC-IC in the receiver side.The Bluetooth module is interfaced with the PIC-IC.

The transmitted location information is now available in the smart phone after pairing with the Bluetooth device. This receiver section mainly consists of a phototransistor, PIC16F887 IC for receiving data, 4 LED's for indicating the incoming data, Bluetooth module for transmitting data to the mobile phone, a power adaptor-port, regulator IC's and capacitors, a pot and LM358 IC for regulation of the light incoming, and a reset push button switch.

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I) BLOCK DIAGRAM

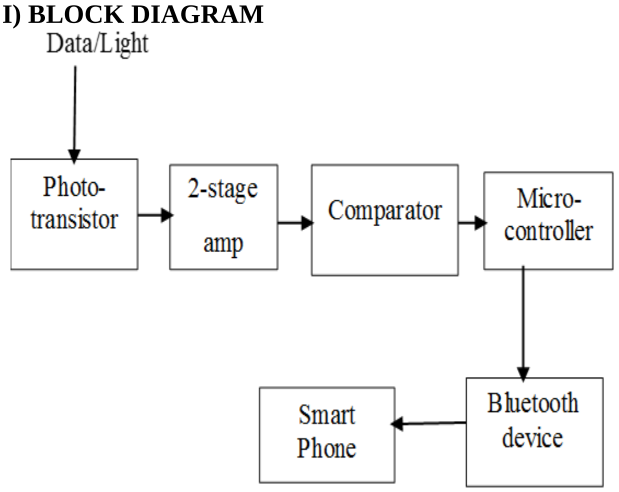

Figure 5.Conceptual Block of VLC – Receiver

The block diagram of receiver includes the photodetector device preferably a phototransistor. It receives the incoming light and convert it into electric signals proportional to the intensity of incident light. Then it is followed by a two-stage amplifier section. LM358, which is an op-amp IC is the main component. Here amplification of signal takes place.The comparator section is optional. In this project we have not utilised comparator section. It is followed by controller unit.

Here also, PIC-IC is the main component. It converts the incoming signal into original data. The final output of microcontroller is the original transmitted data. The microcontroller is connected to Bluetooth device. The Bluetooth device on pairing with a smart phone, gives or displays the original transmitted message or location. Thus positioning is done using visible light.

II) ALGORITHM

The algorithm of the program used in PIC Microcontroller in the Receiver section is given below. This is the basic algorithm (Receiver) of the project.

This is a basic concept of data transfer in VLC communication.

STEP1: START

STEP2: IF F1 0 LOC1 →
ELSE
IF F2 →0 LOC2
ELSE
IF F3 0 LOC3 →
ELSE
IF F4 0 LOC4 →

STEP3: IF RST=1 GOTO STEP 2

STEP4: STOP

III) FLOWCHART

The flowchart of the algorithm (Receiver) is given below

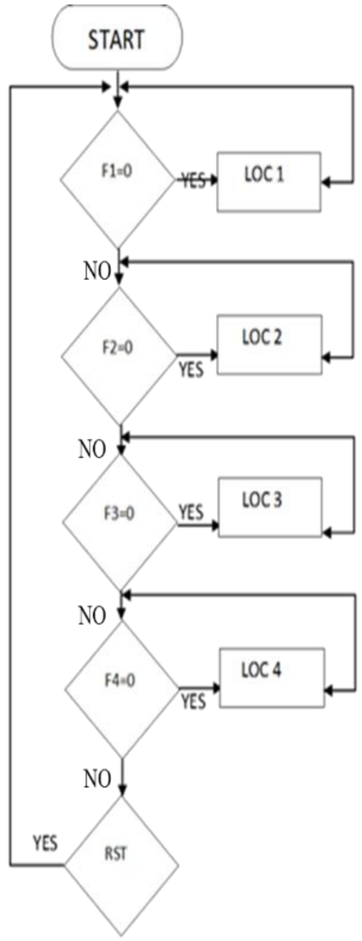

Figure 6. Flowchart of Receiver

IV) CIRCUIT DIAGRAM

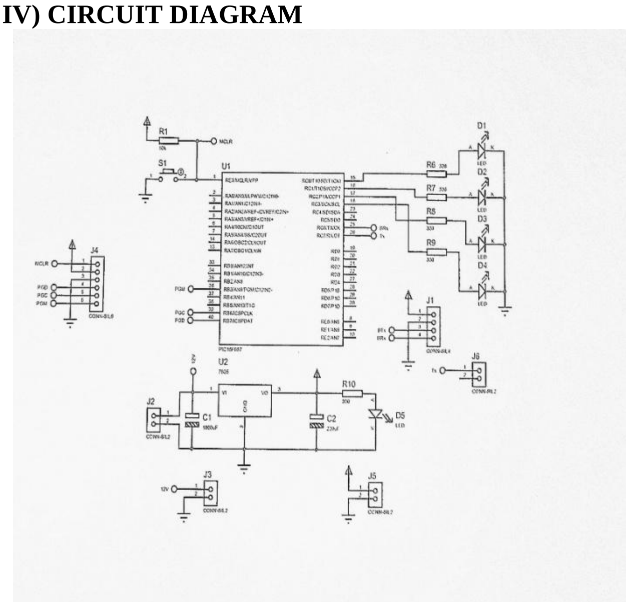

Figure 7. The VLC Receiver

V) IMPLEMENTED RECEIVER SECTION

This receiver section mainly consists of a phototransistor, which collects the incoming light and produce an electric current proportional to the intensity of the incoming light, in the outer circuit. From here the signal gets amplified by a two-stage amplifier (LM 358) which is an OP-AMP IC.

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A pot is provided for its regulation. From there the signal is carried to PIC16F887 IC for receiving data and converting it into the original form, 4 LED's for indicating the incoming data, thatis receiving of location1 indicated by LED1 and so on. Bluetooth module is connected with microcontroller for making the transmitted location information to the smart phone,the circuit is powered up by a power supply unit, the required voltage of 5V for microcontrollers are achieved by regulator IC's and capacitors.

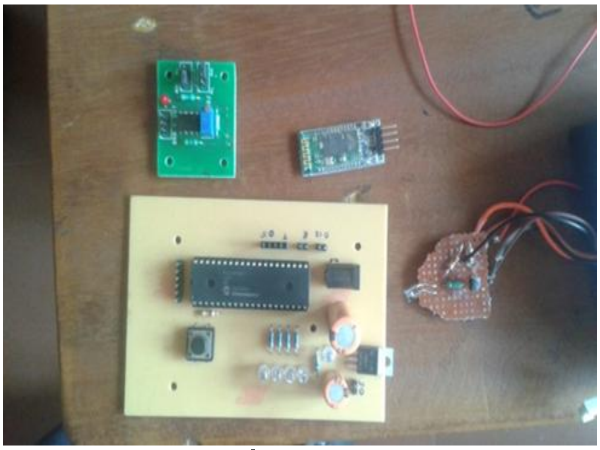

Figure 8. The Receiver Section

4. EXPERIMENTAL RESULTS

Tested the circuit range and did the tests by placing the transmitter and receiver at different distances and it is noted that, at short distance like 5-20 centimetres, the reception efficiency was more.The circuit response was really fast at short ranges, and discontinued the response at ranges above 35 centimetres approximately. The transmitter and receiver should always in line of sight in order to get the output, if any opaque object obstructs the line of sight the output is not received at the mobile phone.

The results of the project obtained in the Digital Storage Oscilloscope (DSO), is given below.

1. LOCATION 1 (Transmitter)

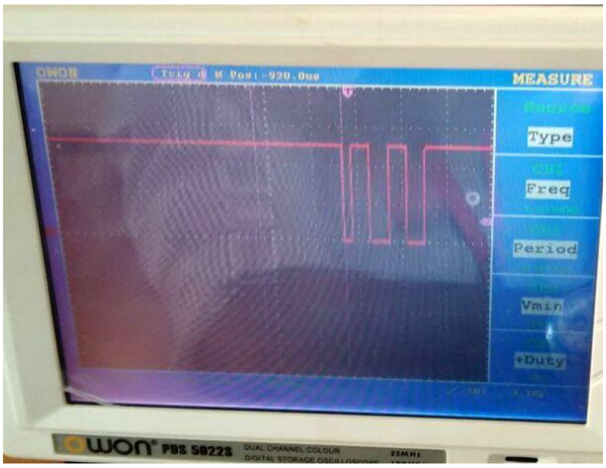

Figure 8. Output at LED (LOC 1).

2. LOCATION 2 (Transmitter)

Figure 9. Output at LED (LOC 2).

3. LOCATION 1 (Receiver)

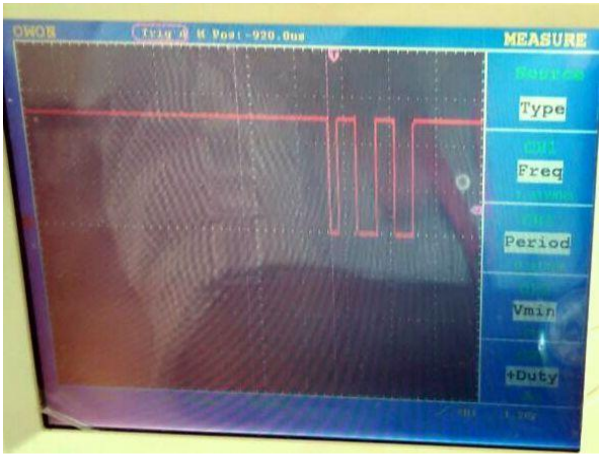

Figure10. Output from Microcontroller at Receiver(LOC1)

1. LOCATION 2 (Receiver)

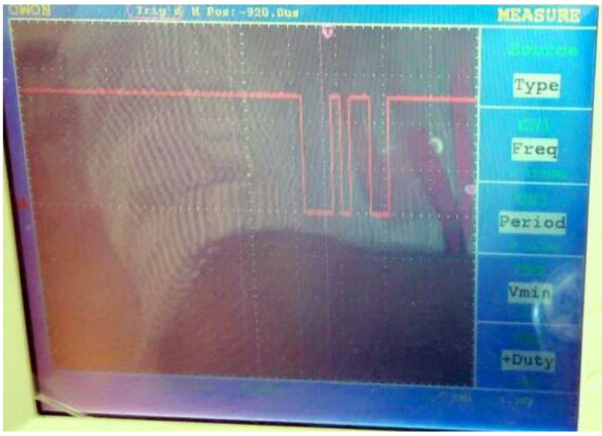

Figure11. Output from Microcontroller at Receiver(LOC2)

5. CONCLUSION

In this paper, we present the design, implementation andevaluation of a visible light-based data-transfer system that exploit LED lamps. The system has no dependencyon network access and can be used immediatelyafter proper

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configuring and calibrating the LED bulbs.Our work confirms the potential ofvisual light for high accuracy indoor positioning. In addition,our work also reveals several insights that deservefurther exploration.Based on the experimental demonstration workthat have been conducted on various distance, we can seethat the distance between the transmitter and receiver caninfluence the system performance. The longer the distancemeans that the signal strength and voltage which has beenreceived by receiver decreased and cause the data loss in thesystem. We can conclude that the maximum distance in thiswork can be achieved only at 20 cm.However in the realimplementation of the VLC system we need to have alonger transmission, so that this system is realiable for thefuture technology. We need to identify more suitable LEDand photodetector for the VLC system to ensure thetransmission distance could be increased.

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REFERENCES

[1] M. Rahman, M. Haque, and K.-D. Kim. High precision indoor positioning using lighting led and image sensor. In ICCIT, pages 309–314. IEEE, 2011.

[2] S. Rajagopal, R. D. Roberts, and S.-K. Lim. IEEE 802.15.7 visible light communication: modulation schemes and dimming support. Communications Magazine, IEEE,50(3):72–82, 2012.

[3] N. Kumar, "Visible Light Communication for Road Safety-Applications," PhD Dissertation, Dept. of Electronics Telecommunication and Informatics, University of Aveiro, Portugal, Dec. 2011