Japan's Visible Light Communications Consortium and Its Standardization Activities

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Why is the standard for visible light communication needed?

Various applications and products of Visible Light Communication are expected to appear.

The problem of the mutual interference between different products and the problem and interoperability are expected if they use different communication methods.

Moreover, it is necessary to consider interference of Visible light communication devices against existing infrared devices.

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- **Why is the standard for visible light communication needed?**
- **<u>Position Detection: One of the important applications of Visible Light Communication</u>**
- **Visible Light Communications Consortium (VLCC)**
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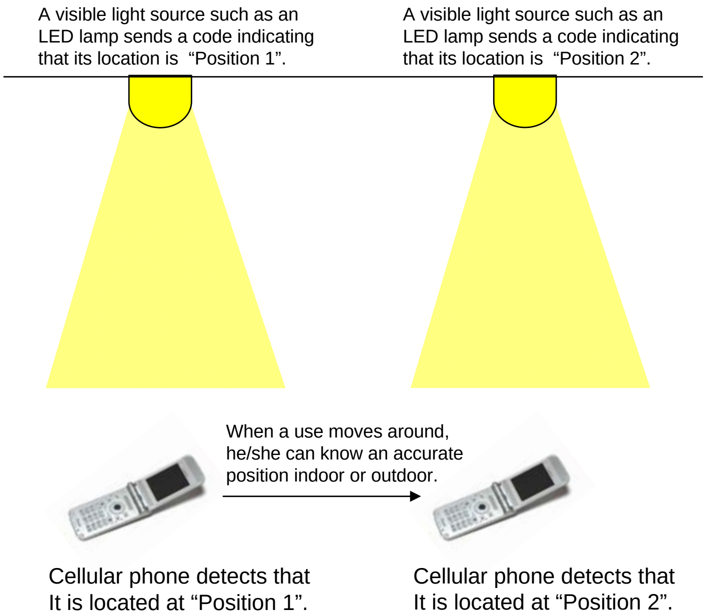
Position Detection

Position Detection is one of the important applications of Visible Light Communication.



It is possible to detect a fairly accurate position using a visible light source if it sends a code indicating its position.

Example 1 of Position Detection:

Merchandise information delivery system that uses visible light ID system standard of JEITA

Prototype made by NEC and Matsushita Electric Works, members of VLCC

Information of products at a supermarket is obtained by a visible light receiver that is installed in a shopping cart.

Example 2 of Position Detection:

Service of delivering location-related information using LEDs of traffic signals

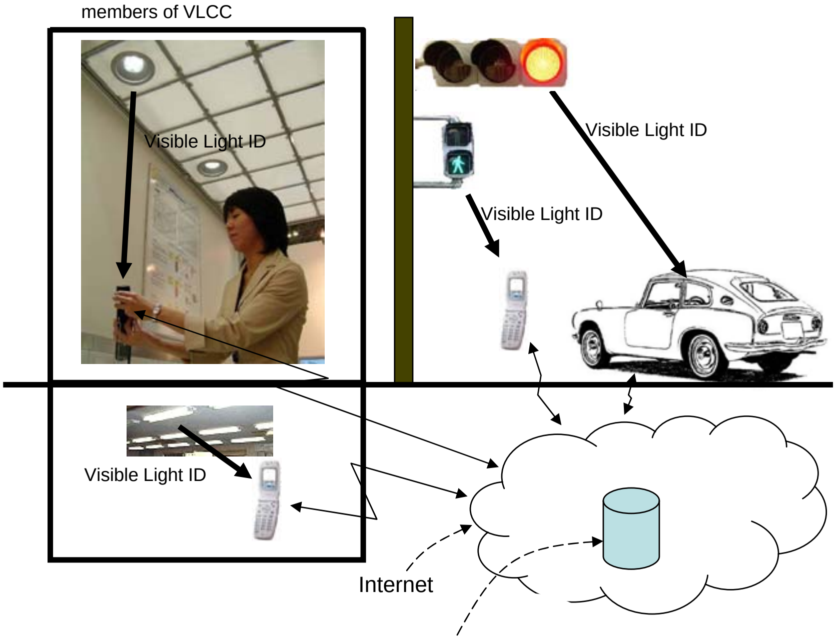
Prototype made by The Nippon Signal Co., Ltd., JAPAN SHOP 2006

Demonstration that sends location-related information from a traffic signal.

Example 3 of Position Detection:

Global location information service that uses visible light ID system and cellular network system

Prototype made by NEC and Matsushita Electric Works, members of VLCC

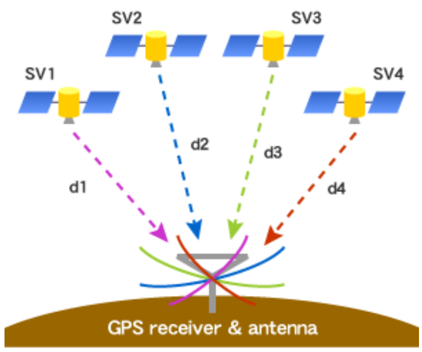


It accesses the Internet by first obtaining code from a visible light source such as LED lights.
It then accesses the location server from the cellular phone in order to obtain location-related information.

Other Position Detection Technologies

GPS
RFID
WiFi
QR Code
Visible Light Communication

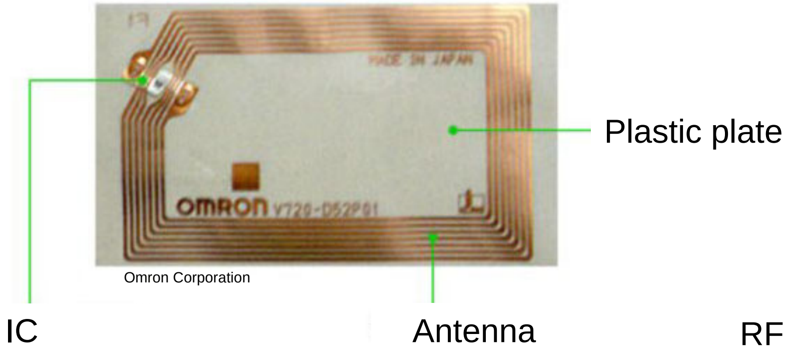
GPS (Global Positioning System)



Users of GPS can know his position by receiving signals from at least 4 satellites.
GPS is used for car navigation systems and some cellular phones.

The problem of GPS is that it cannot be used indoor.

Positioning using RFID



Omron Corporation

YRP Ubiquitous Networking Laboratory

RFID prototype system is used for navigating handicapped persons in Japan

The communication distance ranges from a few millimeters to a few meters depending on its applications.

Positioning using WiFi

Radio signal strength from two or more WiFi base stations and position information of base stations are used for determining user's position.

Data from Rekimoto et al, *"When becomes Where:", Interaction 2007*, 2007

Positioning accuracy using WiFi is sometimes better than GPS as shown in the above picture due to non-sufficient signal strength and mutli-path effect caused by skyscrapers.

Positioning by QR Code

The QR code is two dimensional code developed by DENSO in 1994.

URL can be encoded in QR code and this pattern can be printed and pasted anywhere on the street. Cellular phone users take a picture of the pattern and automatically accesses the URL in order to get the information of the location such as the latitude and the longitude.

Comparison of Positioning Technologies

	GPS	RFID	WiFi	QR Code	Visible Light Communication
Position accuracy	Several meters	Several millimeters to several meters	Several meters to several hundred meters	Several millimeters to several meters	Several meters
Measurement time	A few minutes	less than a second	several seconds	several seconds	less than a second
Measurement device	GPS receiver	RFID reader	WiFi transceiver	image sensor	visible light receiver
Database	not necessary	necessary	necessary	necessary	not necessary
The use of Indoor and underground	Impossible	possible	possible	possible	possible
Recognition of building floors	Impossible	possible	difficult	possible	possible
Applications	Outdoor	In/Outdoor	In/Outdoor	In/Outdoor	In/Outdoor
Possibility of widespread use	Already widely used for outdoor	Need to install RFID tags all over the place	Need to install WiFi base stations all over the place	Need to install QR code stickers all over the place	Need to install visible light transmitters all over the place. Illumination lights can be used as transmitter

Contents

Visible Light Communications Consortium (VLCC)

Chairman:
Professor Masao Nakagawa, Keio University, Japan
Vice-Chairman:
Professor Ken Sakamura, University of Tokyo, Japan
Professor Shinichiro Haruyama, Keio University, Japan
Management:
Globalcom, Tokyo
Date of Founding:
November 2003
Purpose of Visible Light Communications Consortium:
VLCC was established in order to realize safe, ubiquitous telecommunication system using visible light through the activities of market research, promotion, and standardization.
Home Page: http://www.vlcc.net/e/index.html

VLCC member companies

Participation from various industries such as telecommunications companies, lighting companies, LED maker, electric power companies, electronics makers, etc.

List of members:

THE Tokyo Electric Power Co., Inc.
NEC Corporation
Toshiba Corporation
Sony Corporation
The Nippon Signal Co., Ltd.
Toyoda Gosei Co., Ltd.
Avago Technologies Japan, Ltd.
Samsung Electronics Co. Ltd.
Matsushita Electric Works, Ltd.
KDDI R&D Laboratories
NTT DoCoMo, Inc.
Casio Computer Co., Ltd.
Information System Research Institute
Kyocera Corporation
NEC Lighting, Ltd.
Nakagawa Laboratories, Inc.
Fuji Television
Oi Electric Co., Ltd.
Sumitomo Mitsui Construction Co., Ltd.
Wasshoi Co., Ltd.
MoMoAlliance Co., Ltd.
Tamura Corporation
Nitto Denko Corporation
Sharp Corporation
Comtech 2000
Outstanding Technology

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Standardization Activities of Visible Light Communications Consortium

VLCC is working on visible light communication standards. In 2007, VLCC proposed two visible light standards to JEITA (Japan Electronics and Information Technology Industries Association) and the two proposals became JEITA standards in June 2007.

Standardization Activities of Visible Light Communication at VLCC

The standardization of visible light communication is discussed by "Visible Light Communication Standardization Project Group" in JEITA AV&IT system standardization committee.

Members of Visible Light Communication Standardization Project Group :

- Nakagawa Laboratories, Inc.
- NEC Corporation
- Toshiba Corporation
- Sony Corporation
- Technica Fukui Co., Ltd.
- Avago Technologies
- Pioneer Corporation

JEITA Standards of visible light communication

JEITA CP-1221:
Visible Light Communication System Standard

JEITA CP-1222:
Visible Light ID System Standard

These standards documents can be purchased at
http://www.jeita.or.jp/japanese/standard/list/list.asp?cateid=1&subcateid=50

JEITA CP-1221:
Visible Light Communication System Standard

The visible light communication system standard proposed at JEITA is the most basic in the visible light communication system.

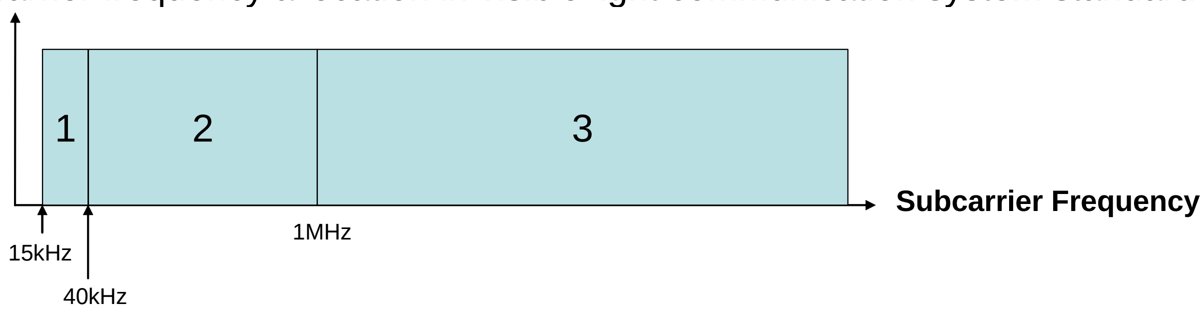
The purpose of this standard:
(a) Present an indicator minimum in order to prevent the interference between different optical communication equipments.
(b) Define a minimum necessary requirement in various visible light communication applications.

JEITA CP-1221:
Visible Light Communication System Standard (continued)

The visible light communication system standard proposed JEITA assumes the range of the wavelength of the light of a visible light communication to be 380nm-780nm, and allows an arbitrary wavelength range of each application in 1 nm accuracy.
(For example, one particular application uses light between 525nm and 575nm)
The standard uses the subcarrier method by modulating the light intensity by a specific frequency.
← By using a different subcarrier frequencies, interference can be avoided.

JEITA CP-1221:
Visible Light Communication System Standard (continued)

Subcarrier frequency allocation in visible light communication system standard



Frequency range 1:
This range is used by JEITA Visible Light ID System
Frequency range 2:
In this range, the noise radiated from the inverter fluorescent lamp is fairly large, it is not appropriate to use this range for visible light communication.
Frequency range 3:
This range is used for the application that needs higher speed communication.

JEITA CP-1222:
JEITA Visible Light ID System Standard (cont'd)

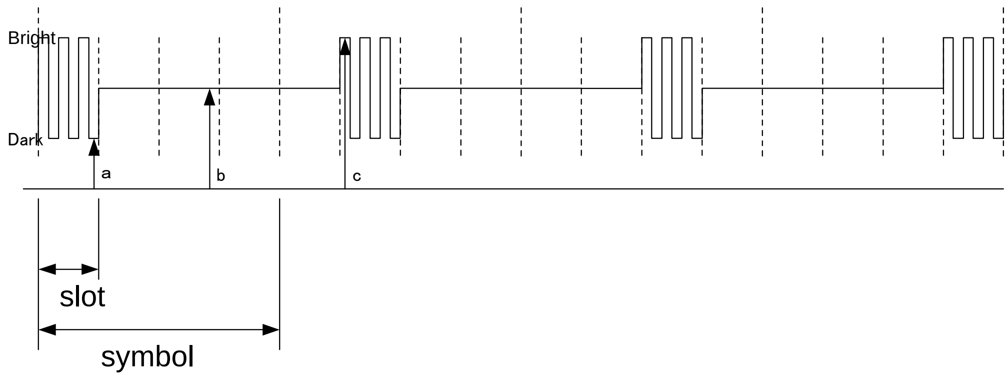
- Subcarrier frequency: 28.8kHz
- Transmission rate: 4.8kbps
- Modulation: Subcarrier 4-PPM

  The modulation was chosen not to cause flickering.
- Error control method: Error detection by CRC
- Transmission contents:

  ID (fixed data) and arbitrary data (non-fixed)

JEITA CP-1222:
JEITA Visible Light ID System Standard

data	0		0		0		1		1		0		1		1	
4PPM symbol	1	0	0	0	0	1	0	0	0	0	1	0	0	0	0	1



Waveform of JEITA Visible Light ID System

Waveform of JEITA Visible Light ID System uses Subcarrier 4-PPM. The Subcarrier 4-PPM has a constant average transmission power, and it does not cause flickering.

Conclusion

Visible light communication technology may be widely used in the future if LED (or OLED) illumination becomes widespread.

The standardization of a visible light communication was proposed by VLCC member companies and two standards were created at JEITA in 2007: one is Visible Light Communication System Standard, and the other is Visible Light ID System Standard.

The use of visible light for position detection is one of the important applications of visible light communication.