VLC System Using PSoC Microcontroller

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Abstract:
Present-day wireless communication has many limitations like bandwidth depletion, security etc. Now-a-days the research on VLC (Visible Light Communications) system is offering new possibilities in overcoming the problems associated with wireless communications system. In the present study a model has been developed for addressing the above issues via Visible Light Communications system for power line communication through an 8-bit PSoC microcontroller. The exclusive PLC chip CY8CPLC10, an 8-bit PSoC3 microcontroller, high intensity pi5 light emitting diodes (LEDs) and the LX1972 visible light sensor were used for the transmitter and receiver. The analysis done using software and hardware components have given voltage fluctuations were evaluated as a function of distance from 10-50cm and given good communication between two computers with minimum loss due to deesalating.

Keywords: VLC (Visible Light Communication), 8-bit PSoC3 microcontroller, Power line communication, Visible light communication.

1. INTRODUCTION
Visible light communications technology uses visible light (380-780nm) to deliver information without the effects of electromagnetic waves, keeping pace with current wireless communications. Lights of general fluorescent lamps or the visible light of light emitting diodes (LEDs) are flickered at visible speeds to send information. Visible light communication does not have any possibility of leaking out when the light is isolated, which offers better security than wireless LAN, and does not suffer performance losses even when a variety of computers are connected at once. This technology is also notable because it uses eco friendly IT green technology rather than electromagnetic waves, which can cause harm to the human body [1].

In addition, due to the decreasing prices of LEDs and improvements in their light emitting efficiency, LEDs are now used in special lighting applications such as mobile device displays, cars, traffic signs, and advertisement panels, as well as in the general lighting market, such as current fluorescent lamps or incandescent lights. Specifically, the emitting efficiency of the white LED has already surpassed that of the fluorescent lamp, and more outstanding products are appearing in the current market. Recently, due to RF bandwidth frequency depletion, confusion possibilities, increasing security requirements, and super-speed ubiquitous communication environments, radio frequency technology and mutually complementary optical wireless communication technologies are being developed at a large number of companies and institutions worldwide [2].

When developing more complex projects, there is often a need for additional peripheral units, such as operational and instrument amplifiers, filters, timers, digital logic circuits, AD and DA
convertors, etc. As a general rule, implementation of the extra peripherals brings in additional difficulties: new components take space, require additional attention during production of a printed circuit board, increase power consumption. All of these factors can significantly affect the price and development cycle of the project. The introduction of PSoC microcontrollers has made many engineers’ dream come true of having all their project needs covered in one chip.

PSoC: Programmable System on Chip

PSoC represents a whole new concept in microcontroller development. In addition to all the standard elements of 8-bit microcontrollers, PSoC chips feature digital and analog programmable blocks, which themselves allow implementation of large number of peripherals. PSoC3 element is inexpensive and provides the PSoC Creator and it is highly flexible custom microcontroller that allows the user to configure the part for the current task at hand. In fact, the PSoC is considered to be a “blank slate” without any stock peripherals. Instead, the user must specify which peripherals are required for the project. The user may place any combination of available blocks to create the resources required. For instance, if the project requires 5 UARTS for serial communication, then the user can place 5 UARTS inside the PSoC. This flexibility allows for extremely efficient designs but requires significant upfront planning by the user.

This study will confirm the possibility of applying this technology for the next generation wireless network by creating a visible light communication transmitter and receiver for power line communication (PLC) using an PSoC. The CY8CPLC10 is designed for systems that require a communication interface over commercial high voltage (HV) or low voltage (LV) powerlines. Typically, these systems consist of a microcontroller or processor along with other electronic components that implement the host application functionality. The PLC interface is provided by integrating the CY8CPLC10 with a powerline coupling circuit [3, 4].

Fig. 1. System architecture.

2. EXPERIMENTS

Visible light communication technology, which has gotten notice as a next generation communication technology, is particularly attractive for home networks. Among the technologies, the visible light communication system is designed and brought into a network using PLC to study application of the LED system that is necessarily relevant for living. The visible light communication system based on PLC uses a commercial alternating current electric power source 220 V/60 Hz power line and an RS-232C cable as a communication medium, and consists of visible light communication parts including PLC receiving and transmitting parts. The system developed in this study transmits the input data from a computer to a PLC transmitter through an RS-232C port. This signal is converted into the transistor-transistor logic (TTL) signal level through DS276 chip, and is transmitted to the PLC receiver through a power line cable after the data is transmitted to an exclusive PLC chip through an 8-bit microcontroller. Data that is transmitted after these processes is received by an exclusive PLC chip that is attached to the PLC receiver, and this signal passes through the 8-bit microcontroller and is transmitted to the visible light communication light emitting parts. After the data is received from the visible light
receiving sensor through the LED of the visible light communication light emitting parts, the lowered data signal is amplified by the OP-amp circuit, and the RS-232C cable is used through the Microcontroller and the DS276 chip to send the data to other computers [7].

2.1 Composition of the system
The design in this study uses a commercial alternating current electric power source, a 220 V/60 Hz power line as the communication medium, and the system shown in Fig. 1 to transmit the information. The distance between the light emitting parts and the receiving parts of the visible light communication should be between 10-50 cm, and each LED should be positioned horizontally. Each transmitting and receiving part has its own LED in order to verify the information transmitting and receiving process so that the conditions and power conditions can be checked in real time. Real time checking of the transmitted and received data is achieved by using the hyper terminal window using Embedded C programming. The visible light communication data transmitting and receiving program uses letters so that the data transferred between computers can be checked by eye. In this manner, the performance of the processes can be monitored and evaluated. In this process, the transmitting and receiving port drivers of both computers should be well connected in order to communicate.

2.2 PLC receiver
Figure 2 is the circuit image of the PLC receiver used in this study. The PLC receiver mainly consists of the exclusive CY8CPLC10 PLC chip, microcontroller PSoC3 chip, and an DS276 chip for the TTL signal level change. The DS276 chip balances the voltage gap for the serial communication between the PC and the microcontroller. When data is transmitted using the RS-232C cable in PC1, the data is transmitted to the power line through the exclusive PLC chip and the PSoC microcontroller.

2.3 PLC receiver and visible light communication transmitter
This part of the system has a similar composition to the PLC receiver, except that 3 of the 5pi LEDs are added to the light emitting parts design. The signal that comes through the power line is received through the exclusive CY8CPLC10 PLC chip, and is transmitted to the LED through the PSoC3 microcontroller chip. Figure 3 shows the transmitter circuit image of the visible light communication system.

2.4 Visible light communication receiver
The composition of the visible light communication receiver is different than that of the PLC transmitter or visible light communication receiver, as shown in Fig. 4. The visible light communication receiver does not have an exclusive PLC chip, so it only has a visible light receiving sensor and PSoC3 microcontroller to receive the information. The data is received in PC2 through PSoC3 microcontroller, which is an 8-bit microcontroller, and OP-Amp LM324N after the data is received from the LED through the LX1972 visible light receiving sensor [8,9].
3. RESULTS AND DISCUSSION

Figure 6 shows the process in which the letters are transmitted and received. The transmitter and receiver of the materialized system are connected directly to the RS-232C port of the computer, and the output value is calculated, which is detected by the visible light receiving sensor using an oscilloscope. The transmitting and receiving waveforms can be checked and verified as shown in Fig. 6. Figure 7 shows the values obtained from voltage change through visible light receiving sensor from a voltage that 5 V is approved by distance using an oscilloscope.

In the case of the white LED, the voltage at a distance from 10-35 cm was constant, but the voltage for a distance over 35 cm showed a dramatic voltage decrease. A voltage loss of 0.67 V was confirmed, with a voltage of 4.32 V at 10 cm to a voltage of 3.65 V at 50 cm. Also, in the case of the red LED, the voltage from 10-30 cm was constant, but there was a dramatic voltage decrease at distances over 30 cm. At a distance of 50 cm, the voltage was 3.26 V, so that 1.06 V was confirmed as the voltage loss. The voltage loss of the green LED is 1.46 V, and the voltage loss of the blue LED is 0.47 V, which shows the best performance among the LEDs.

Figure 8 shows the Visual C++ program that general users can easily take and adapt by adding letters to verify successful data transmissions between the computers. In this manner, "HELLO!!" was used as the input and was transmitted to the other computer. The results were checked, and the blue LED showed the best performance when evaluated using an oscilloscope.
new issues were found by using the estimated values.

In this study, the performance under changing conditions was evaluated, and the efficiency of the light emitting part and the receiving sensor of the visible light were studied so that better communication conditions can be achieved in the future. Continuous study and improvement are required. This study also confirmed the possibility of applying this technology for the next generation network.

REFERENCES