ISSN : 1226-7244 (Print)
ISSN : 2288-243X (Online)
논문번호 19-03-01
j.inst.Korean.electr.electron.eng.Vol.23,No.3,751~755,September 2019
http://dx.doi.org/10.7471/ikeee.2019.23.3.751

An Interactive Physical Computing Based LED CUBE with Infrared Ray Distance Sensor

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Abstract

This paper introduces a LED CUBE tool interacting with a distance sensor to solve real life problems in the physical computing field. Students can experience interactive education and intuitively understand the cubic operations with 3-dimensional animations obtained from a 3 x 3 x 3 LED CUBE and a distance sensor connecting to Arduino. If the proposed LED CUBE is applied in physical computing section of the Information curriculum of middle school, students are expected to improve their computational thinking ability to solve problems in real life and other areas creatively and efficiently.

Key words : LED CUBE, Infrared ray distance sensor, Arduino, Physical computing, Interactive

Ⅰ. Introduction

The fourth industrial revolution plays a vital role in the development of the world these days. Therefore, education needs rapid change to follow the hot trend. Educational innovation is taking place around the world to break away from traditional education systems and prepare for a changing world[1, 2].

The Korea Educational and Scientific Information Service surveyed 16 middle school Information textbooks and suggested "How to use the physical computing paradigm in the Information curriculum according to the 2015 revised curriculum". In the survey, physical computing classes are mainly composed of actuators such as LEDs, buttons, and various basic sensors[3]. However, the class contents include only a basic process of introducing physical computing, and there is a lack of high level educational programs that can solve the problems in a changing world through software knowledge[4]. Therefore, an educational tool of the advanced level is developed in this study. By using 3 x 3 x 3 LED CUBE, it is possible to develop knowledge level and practical problem solving ability for students[5]. 3-dimensional (3D) animations are generated according to learner's reaction by linking infrared (IR) distance sensor.

The organization of this paper is as follows. In Section 2, we present the LED CUBE linked with IR distance sensor. In Section 3, we explain the operation principle and the experimental results of 3D shape. Then, we present animation operation when the LED CUBE responds to the IR distance sensor. Section 4 gives the conclusion of our study.

Ⅱ. Architecture

2.1 LED CUBE Implementation

The LED is composed of two legs, the long leg

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Manuscript received, Jul. 5, 2019; revised Sep. 23, 2019; accepted Sep. 24, 2019.
※ This work was supported by the Basic Science Research Program through the National Research Foundation of Korea funded by the Ministry of Education, Science and Technology (NRF-2019R1F1A1055593).

is the positive pole, and the short leg is the negative pole. The LED turns on only when the electrical current flows from the positive pole to the negative pole. LED CUBE, which is a cube-shaped tool where LEDs are arranged in three dimensions, can control the lighting status of each LED to present 3D shape and animation. 9 LEDs are used to make a 3 x 3 grid with the positive long poles of the LEDs are bent 90° and connected to create one layer. 3 layers are then stacked to form the LED CUBE[6]. The negative poles of the LEDs at the same position in 3 layers are connected to make totally 9 columns to complete the LED CUBE.

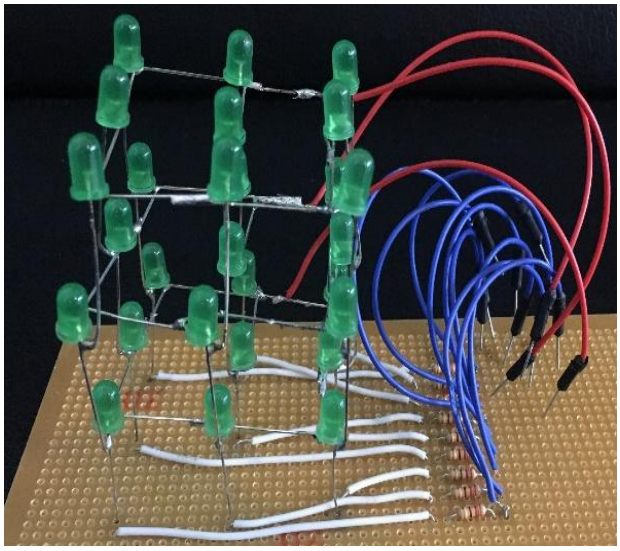

Fig. 1. LED CUBE.

The LED CUBE is fixed to a square plate printed circuit board at regular intervals so that it can be controlled by connecting it to the Arduino and sensor[7, 8]. By calculating the value of the resistor through the circuit configuration, the 220Ω resistor of each of the nine pillars is connected to limit the power of the LED and protect the circuit[9]. The LED CUBE is composed of 27 LEDs in height, width and depth dimensions and the 3D shape can be directly seen inside the cube because it is a grid structure in which the LEDs are arranged at regular intervals(Fig. 1).

2.2 Connecting LED CUBE and Infrared Distance Sensor to Arduino

Arduino's microcontroller unit is a device that contains a processor, a memory, and programmable IO pins in a single integrated circuit. The actuator and sensor can be connected via IO pins and programmed into the computer via the connecting pins address[10, 11].

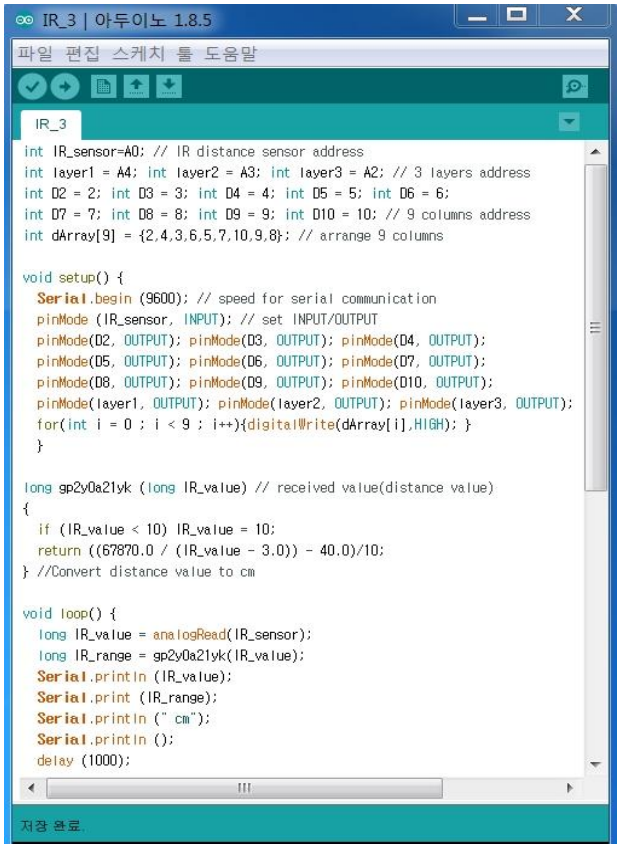

Fig. 2. LED CUBE Code.

The LED CUBE consists of 9 columns and 3 layers. Through the jumper wire with the pins on both ends, one end connects each one of 9 columns and the other end connects the IO pins of the Arduino[12]. Likewise, 3 layers are connected to the Arduino using jumper wires.

Finally, the IR distance sensor consists of positive and negative lines and pins that can be connected to other devices. Then, the IR sensor can be programmed into the computer by plugging it into the Arduino.

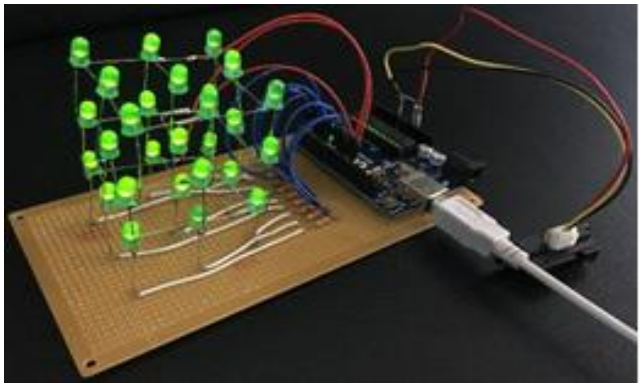

Fig. 3a. All the LEDs of the LED CUBE are lighting up when the distance is less than 3cm.

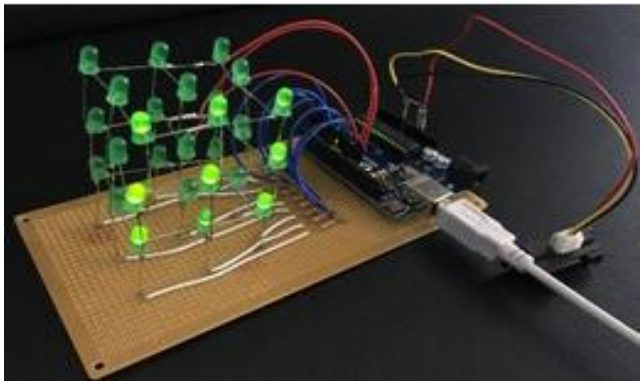

Fig. 3b. LED CUBE is lighting up the diagonal when the distance is from 3cm to 6cm.

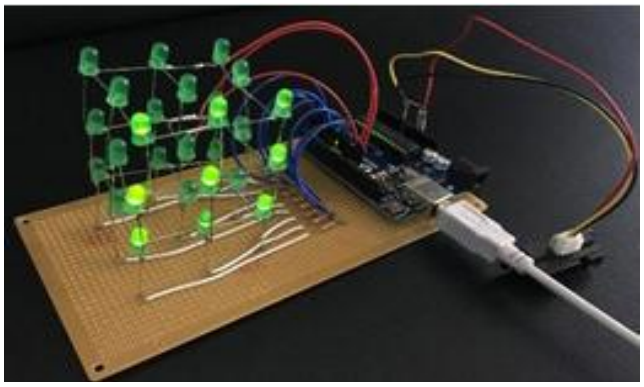

Fig. 3c. LED CUBE is lighting up the front vertical side when the distance is from 6cm to 9cm.

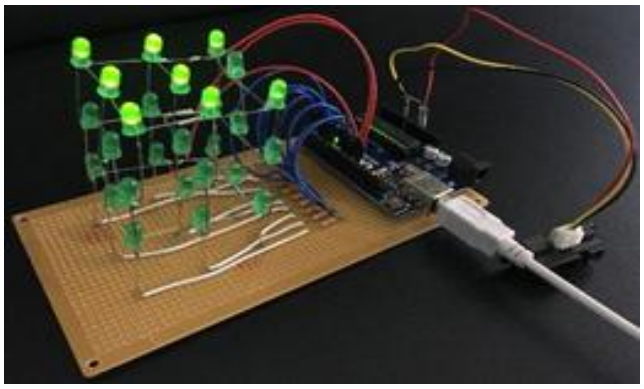

Fig. 3d. LED CUBE is lighting up the top horizontal layer when the distance is from 9cm to 12cm.

III. Experience Result

In the experiment, the address values of the IR distance sensor and 9 columns and 3 layers of LED CUBE are declared and the speed for serial communication is set to 9600 [baud]. The learner programs to store the received value (data) recognized by the IR distance sensor in the variable data[13, 14].

The animation of the LED CUBE changes according to the distance value. Specifically, if the distance value is less than 3cm, all the LEDs of the LED CUBE light up (Fig. 3a), and when distance value is from 3cm to 6cm, the LED CUBE lights up only on the diagonal (Fig. 3b). The LED CUBE shows the animations by sequentially lighting up all single vertical sides from front to back (Fig. 3c) when the distance is from 6cm to 9cm or horizontal layers from top to bottom (Fig. 3d) for further distance.

According to the results of this experiment, the LED CUBE shows a 3D shape and operates animations according to the distance recognized by the IR distance sensor. If LED CUBE sets various operations by setting various interval of received values, it will become more effective educational tool[15].

IV. Conclusions

In this paper, we propose an educational tool that can improve the advanced knowledge and practical problem solving ability based on the physical computing section of middle school Information subject. The proposed method is to develop LED CUBE to realize 3D shape and

animation operation according to the learner's response by connecting the IR distance sensor.

The experimental results show that the proposed method can enhance the knowledge and practical problem solving ability of the students at the advanced level. In future works, we will perform operations for the LED CUBE via the interaction with the distance sensor.

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