LED Dice with 7 Segment Display

Curriculum for Applied Learning

Digital Logic and Design – CSE1003

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ABSTRACT

The aim of this project is to design an LED dice with a 7 segment display, which works when a button is pressed. The project is made using Arduino UNO.

An LED dice is an electronic version of the conventional dice. The LED dice simulates the rolling of a conventional dice when the roll button is pressed, and an indicator LED lights up to indicate that the dice is working. Then a random number between 1 and 6 is generated, the 6 LEDs are used to indicate the number. This random number generated is also displayed on the 7 segment display. We have used Arduino because it is a widely used, offers cross-platform implementation and is cost-effective.

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1. Introduction

1.1 Purpose

An LED dice is an electronic version of a conventional dice. When the button is pressed, and indicator LED lights up to show that the dice is working. Then, the dice simulates the rolling of a conventional dice and generates a random number between 1 and 6. It the uses 6 LEDs to display a pattern according to the number generated, and the same number is displayed on the 7 segment display, simultaneously. After a 2 second delay, both, the LEDs as well as the 7 segment display turn off, until the button is pressed again and the cycle repeats.
Arduino UNO has been used to design and implement the entire setup.

1.2 Problem Statement

Design an LED dice with a 7 segment display, which works on the push of a button, and simulates the roll of a conventional dice by generating and displaying a random number between 1 and 6, simultaneously on the 6 LEDs and the 7 segment display.

2. Project Plan

2.1 Components Required

2.1.1 Software Requirements

The Arduino software (IDE) was the only software component required to develop our project.

2.1.2 Hardware Requirements

The hardware components utilized for the development of the project are:

- 1 x Breadboard
- 1 x Arduino UNO
- 6 x LEDs (white)
- 1 x LED (red)
- 1 x Button
- 1 x 7 Segment Display
- 2 x 220 ohm resistor
- 1 x 10k ohm resistor
- 1 x USB A-B cable
- 30 x jumper wires

2.1.3 Description of Components

The 6 white LEDs and the 7 segment display are used to display the random number generated and to simulate the rolling of a conventional dice. The red LED acts as an indicator of the functioning of the LED dice. The button is used as an input for the dice to start functioning. All of these components are attached to the breadboard for ease of making connections.

The 220 ohm resistors have been used to ground the 7 segment display, and the 10k ohm resistor to ground the button. The jumper wires have been used to make the ground connections, and to connect all of the components to the input and output pins of the Arduino UNO board. The USB cable has been used to connect the Arduino board to the USB post of a laptop for power input.

2.2 Cost Analysis

Among the components used for the project, the major cost factor turned out to be that of the Arduino UNO board, costing Rs. 530.

The other components were comparatively inexpensive, bringing the total financial cost of the entire project to Rs. 600, approximately, thereby at a capital of Rs. 100 per head.

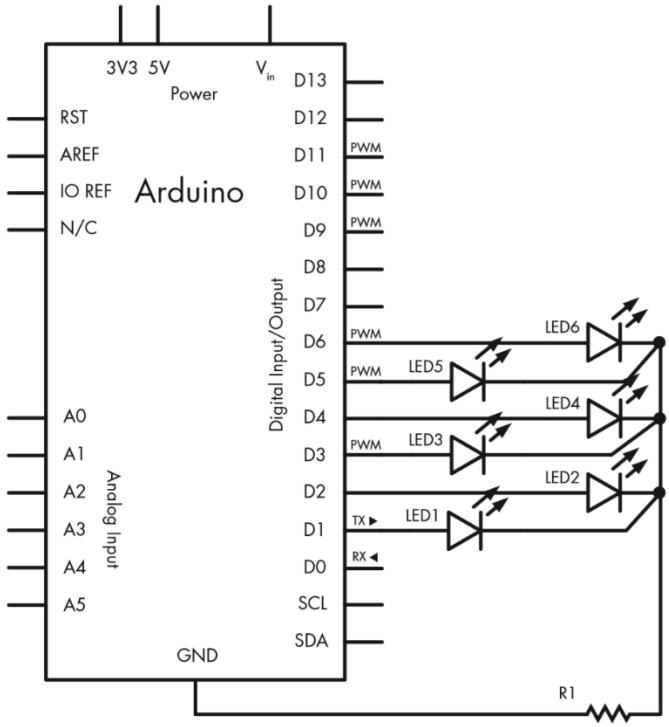
More than the financial aspect, a significant amount of time has been spent on the project, in research about the best ways to go about in the development of the project. Arduino has been used as the platform, because of many significant reasons.

Firstly, Arduino is very widely used, and offers cross-platform implementation. It can take inputs from a variety of switches or sensors, and can control a variety of lights, motors and other physical outputs. Moreover, it is inexpensive and can easily be purchased online or at electrical hardware stores. The biggest advantage, however, is that it has a simple and clear programming environment, and is an open-source and extensible software and hardware. Thus, even though an Altera board simulated using ModelSim would have provided more specific and accurate results, it is much more expensive. Thus, I chose Arduino over Altera because of so many additional benefits that Arduino provides.

3. Design – Circuit Diagram with Modules

3.1 LED dice

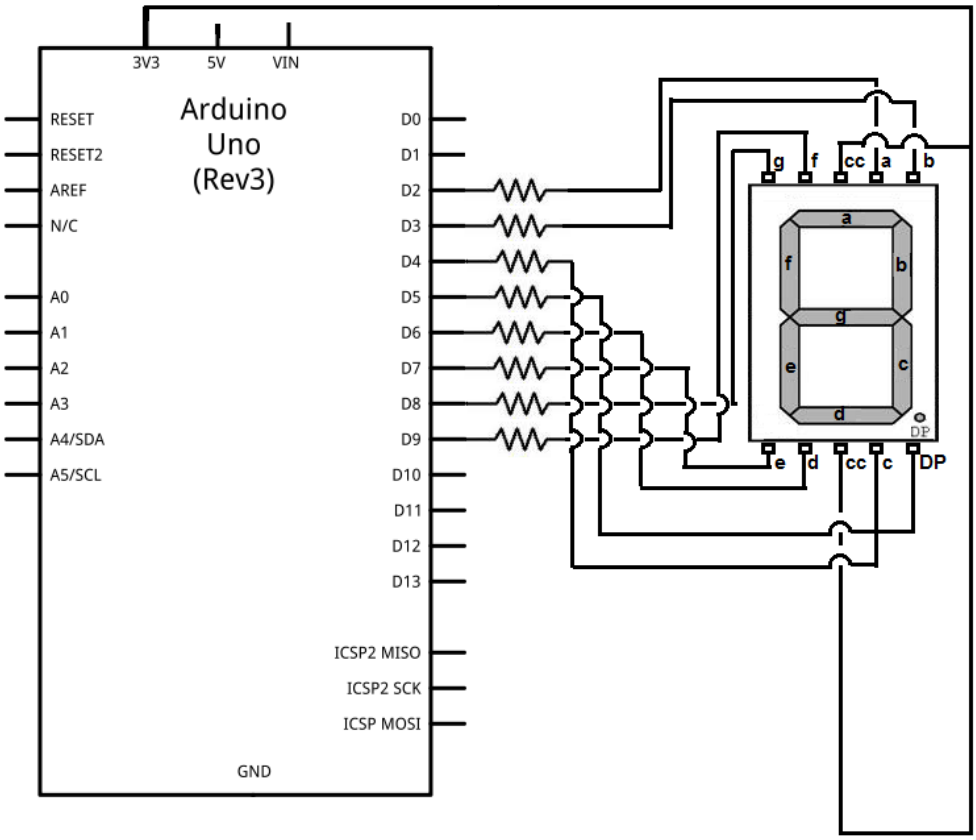
The circuit diagram for the LED dice is:



The positive terminal of the 6 LEDs are connected to the digital output pins of the Arduino UNO board, from pins D6 to D1. The negative terminals of the LEDs are connected to the ground of the Arduino board.

3.2 7 Segment Display

The circuit diagram for common anode 7 segment display is:



The circuit diagram of the 7 segment display shows the seven segments marked from “a” to “g”, and the pins for these segments connected to the digital output pins of the Arduino UNO board. The pins of the 7 segment display which have been marked as “cc” are to be connected to a 220 ohm resistor each, and then connected to the 3.3V supply of the board. The pin marked as “DP” is to control the decimal dot in the display. That pin is unused in the project.

4. Test Cases

The LED dice simulates the rolling of a conventional dice. Thus, similar to a conventional dice, it displays numbers from 1 to 6.

In binary form, the representation upto 6 requires 3 bits. However, representation using 3 bits includes the numbers 0 and 7. These numbers are taken as don't care conditions while making the truth tables.

4.1 LED dice

The truth table for the electronic dice is:

A	B	C	L1	L2	L3	L4	L5	L6
0	0	0	X	X	X	X	X	X
0	0	1	0	1	0	0	0	0
0	1	0	1	0	1	0	0	0
0	1	1	1	0	1	0	1	0
1	0	0	1	0	1	1	0	1
1	0	1	1	0	1	1	1	1
1	1	0	1	1	1	1	1	1
1	1	1	X	X	X	X	X	X

A, B and C together represent the binary equivalent of the random number generated.

The truth table tells us which LEDs will be switched on for different values of the random number, from 1 to 6. The numbers 0 and 7 are don't care conditions.

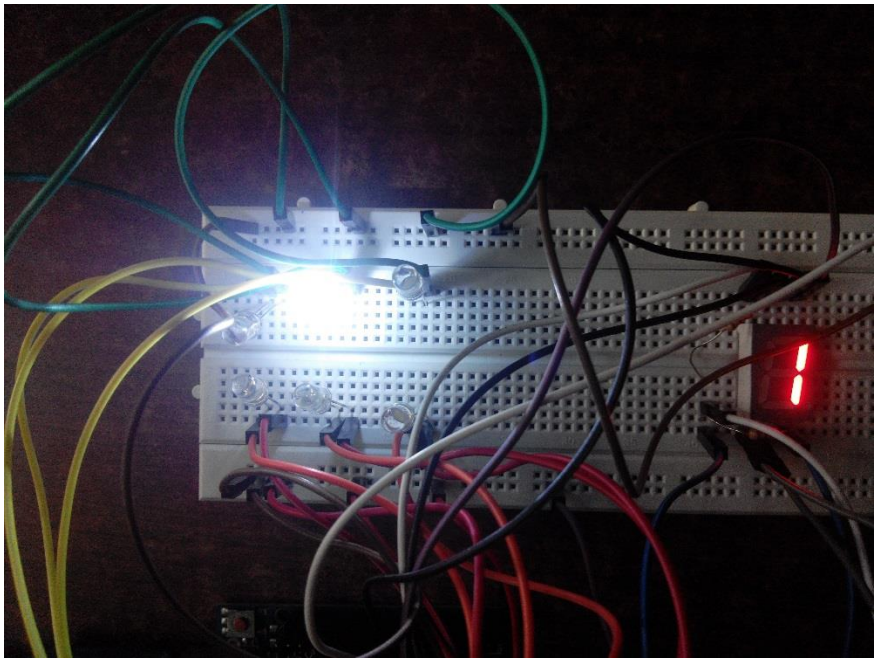
4.2 7 Segment Display

The truth table for the common anode 7 segment display is:

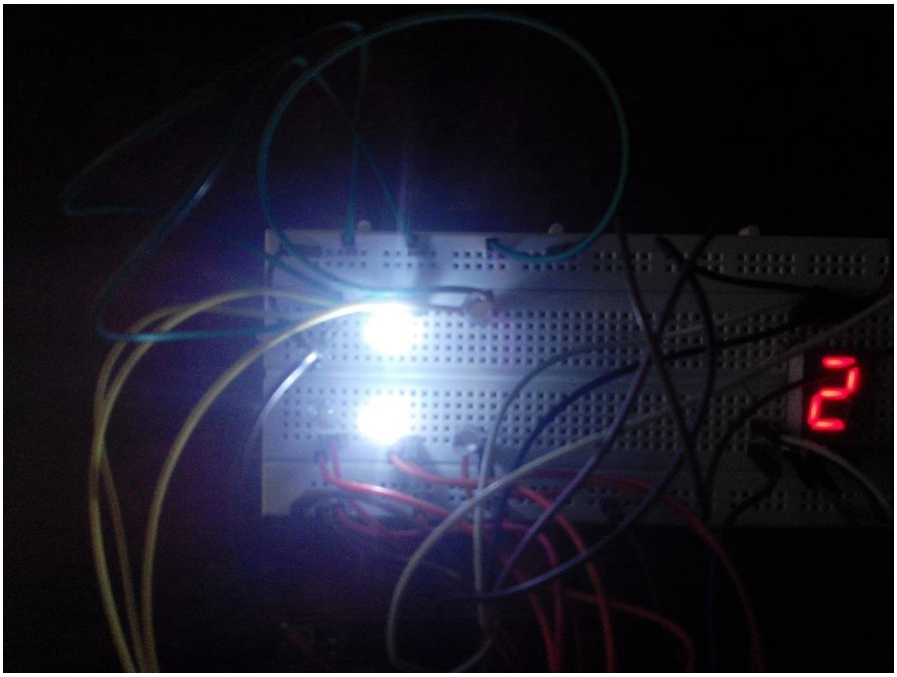
X	Y	Z	a	b	c	d	e	f	g
0	0	0	X	X	X	X	X	X	X
0	0	1	1	0	0	1	1	1	1
0	1	0	0	0	1	0	0	1	0
0	1	1	0	0	0	0	1	1	0
1	0	0	1	0	0	1	1	0	0
1	0	1	0	1	0	0	1	0	0
1	1	0	0	1	0	0	0	0	0
1	1	1	X	X	X	X	X	X	X

X, Y and Z together represent the binary equivalent of the random number generated.
“a” to “g” represent the 7 segments that may light up to display the random number. The segment for the decimal is unused. Moreover, the numbers 0 and 7 are don’t care conditions. For any particular case, whichever segment lights up, that segment is represented by “0” (LOW) and the unlit segments are represented by “1” (HIGH).

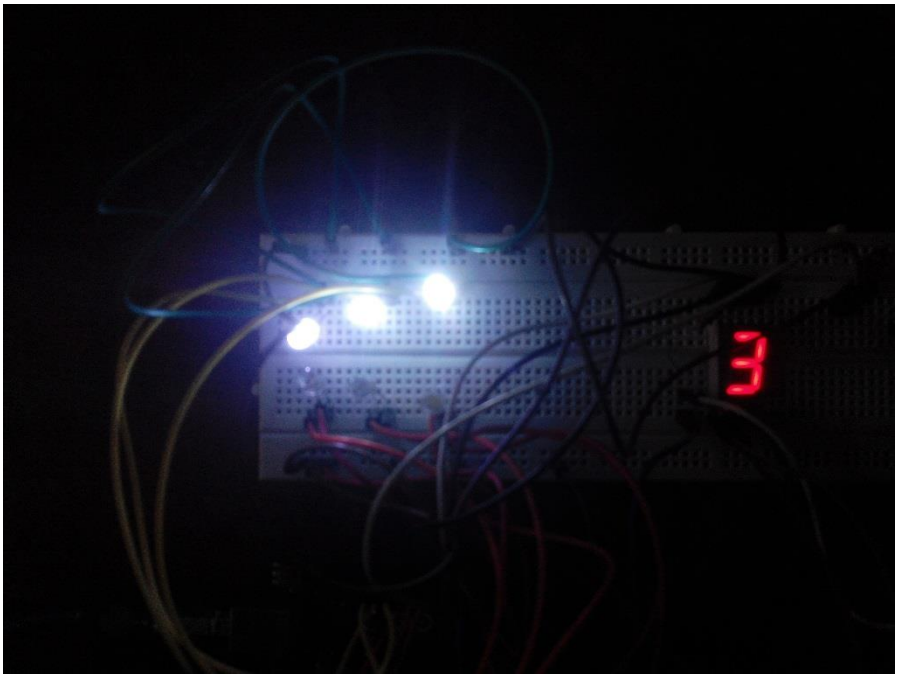
5. Snapshots for all possible cases



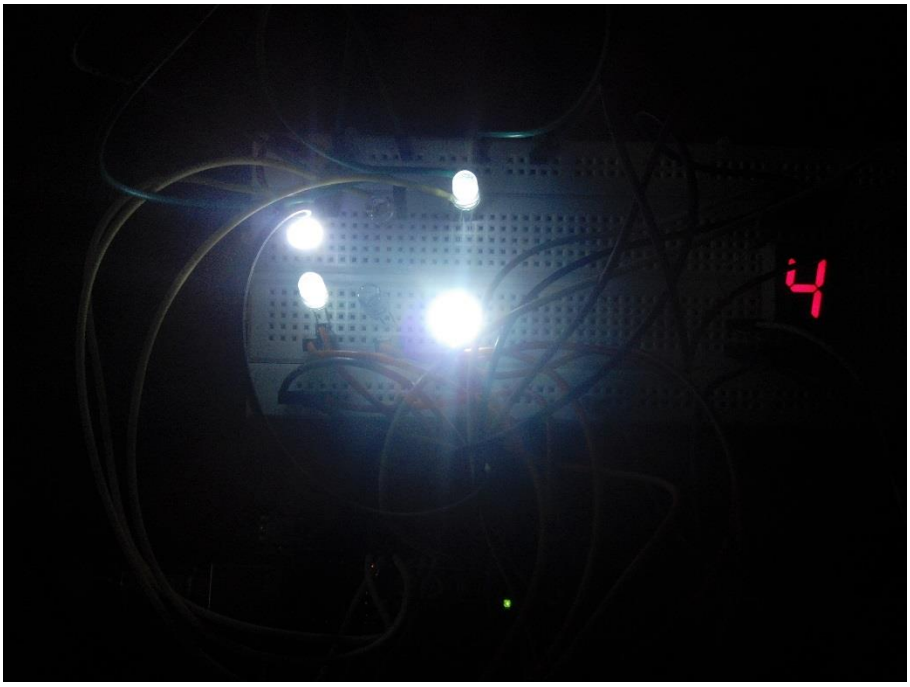
Dice showing 1



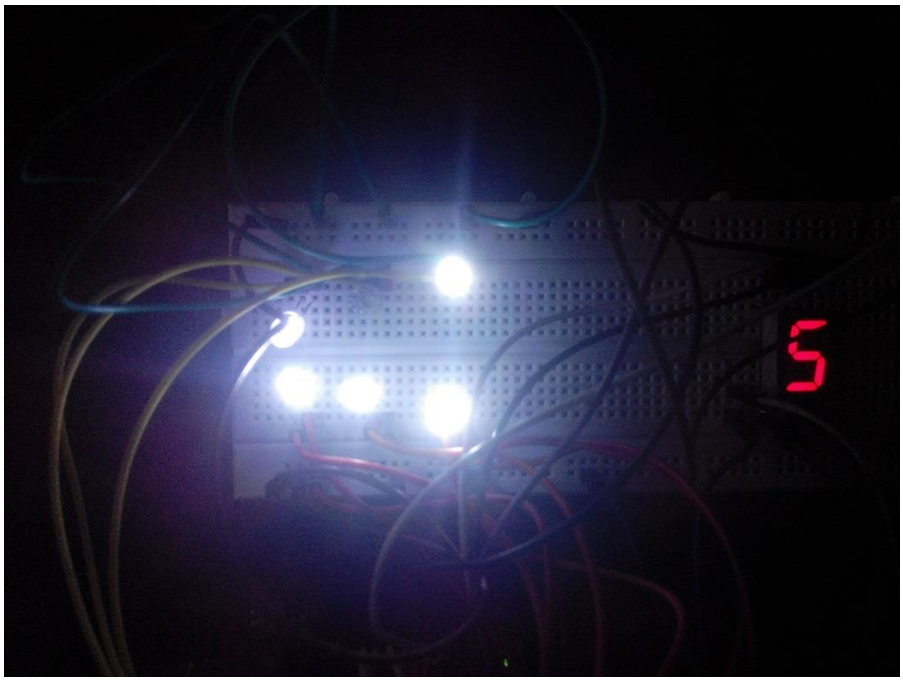
Dice showing 2



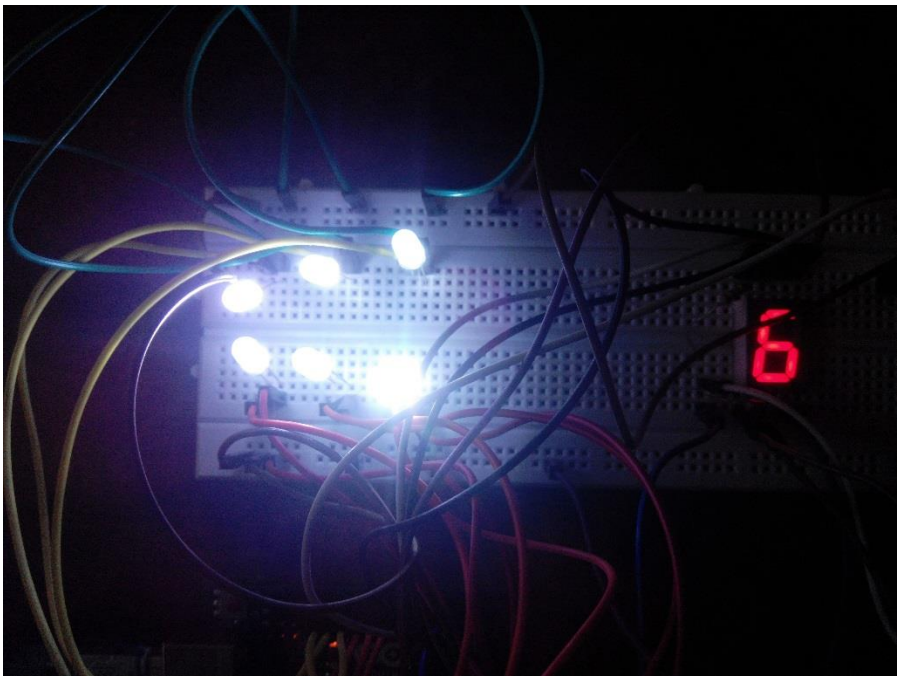
Dice showing 3



Dice showing 4



Dice showing 5



Dice showing 6

6. Conclusion

In this project, I have simulated a conventional dice in the electronic form using nothing but a few lines of code, LED lights, a 7 segment display, some wires and a button, and the Arduino UNO board. The project, as a whole, has been as interesting as it has been enlightening, from learning how to use the Arduino board, to writing the code for it, and even learning which components need which connections.

Digital logic and design is a very important part of this era of technology, and making the electronic dice, which included components such as LEDs and a digital display, has proven that this aspect of the modern era will play a major part in our day to day lives in the years to come.

7. References

- M. Morris Mano (2006). Digital Logic and Computer Design, Pearson Education, Inc. <For referring technical explanations>
- https://www.arduino.cc, the official Arduino website. <For referring implementation issues, and for the Arduino IDE>