Modeling, simulation and control of electronic circuits in the application electronics lab

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Abstract: In the paper are present description, properties and use of application Electronics Lab/from Autodesk 123D CIRCUITS environment, for the modeling and simulation of electrical/electronic circuits in technical systems. This application can be used as an efficient tool in the realization of teaching themes from Electrical installations and Digital electronics. It is available through the Internet, contains a number of components, and also is gratuitous. Characterized by a simple interface on the desktop/protoboard with placing of electrical/electronic components/devices and with the ability to change certain characteristics the same. Quickly, clearly and in a visually interesting way in the application are simulated circuits in installations of appliances, machines and buildings. The application integrates the Arduino microcontroller platform, contains sensors, relays and measuring devices. It is especially important that Electronics Lab allows the entry code for the programming and consequently control of the created models; as shown in paper for LED, traffic light and display, in real time.

Keywords: teaching electrical engineering, control, Arduino, programming

1. INTRODUCTION

Modern teaching requires a new approach to the implementation of the teaching techniques. Application Electronics Lab for modeling/simulation of electrical/electronic circuits is certainly an example of good practice for the use of modern ICT considerable simplicity, quality graphic/environment and accessibility (does not require the installation of special software and it's free). It is part of Autodesk 123D Circuits environment and can be used in the realization teaching materials Electrotechnical Installations and Digital Electronics.

Electronics Lab contains a number of components: batteries, resistors, lamps, LED, Arduino boards, sensors, relays, etc. The created models are stored in the database, and can be easily modified/Edit. There are also specific measuring devices for performing electrical measurements in the car.

In addition it allows the write program code, that is programming with the Code Editor to control models of technical systems in real time.

It is assumed that for students it will be interesting, interactive and allow the expression of

creativity. At the same time the application allows the acquisition of knowledge, skills and competencies of engineering/electrical engineering and computer science, which are developing in an intensive and very promising for the selection of future interest in the field of technics.

2. CHARACTERISTICS OF THE APPLICATION ELECTRONICS LAB

Electronics Lab is part of Autodesk 123d D Circuits environment (https://123d.circuits.io). This is a quality online tool, ie. web service for project development in electrical engineering/electronics. With Arduino platform it has implementation and in programming. Thereby it is used quite simple functions void setup and void loop.

Electronics Lab applications is relatively easy to use, free and suitable for the simulation of electrical circuits. It may serve to explain programming to students in a simple way and how to connect electronic components in more or less complex circuits, especially if there is not real Arduino microcontroller [1].

In options there are a lot of components and a library, which is quite enough to work in this environment, even at the higher levels/secondary technical school.

Operating environment/parts:

- ProtoBoard
- Components
- Start/Stop Simulation
- Code Editor
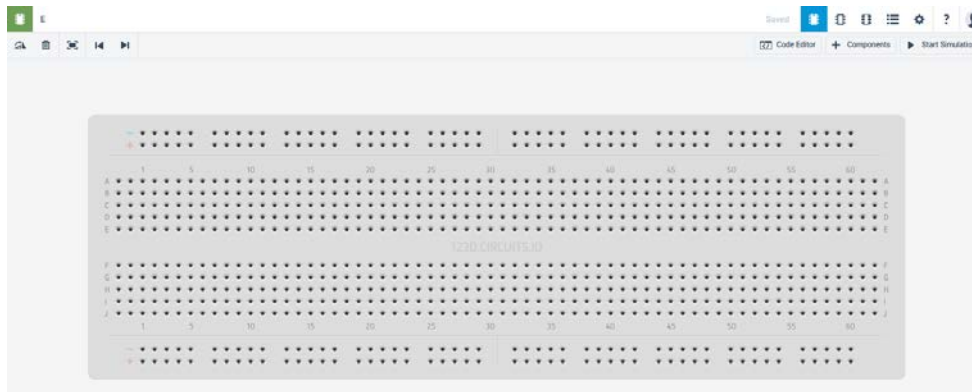- Edit
- Lab View/View Schematics/PCB View [1].

Figure 1. *ProtoBoard*

In the section Components of the application there are a large number of components for the representation of the electrical/electronic circuits, machines, devices. In addition to active and passive electronic components, batteries, several types of Arduino boards, there are sensors, relays, measuring devices/multimeter [1].

Functionality of models is created and checked by the command Start/Stop Simulation. Only certain components from the Electronics Lab applications is shown in Figure 2. Formed models are automatically assigned names and simultaneously stored in the database, a possible quick and easy shift characteristics of the components, as well as the existing

models/Edit. Marked components are deleted with Delete and rotated with Rotate. Options for graphical views of the model are: LabView, View Schematics, PCB View [1].
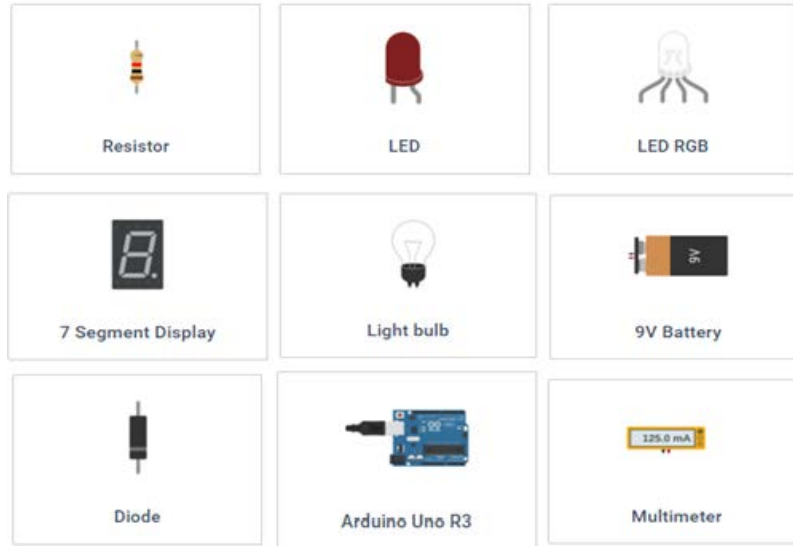

Figure 2. *Components*

3. MODELS PROGRAMMING AND CONTROL

Electronics Lab applications other than creating a model of electrical circuits and allows the development of software codes in the Arduino environment. Command Code/Editor, below the graphic display models, opens space for entering codes [2]. The codes are directly written in the lines or can be copied from other editors. At the end of the command Upload/Run the code is implemented, a Start Simulation command executed. Thus, in real time allows testing of code and control made models.

A simple model of an electronic circuit, made of LED and resistors (with Arduino-powered) is shown in Figure 3 [3], a corresponding code to turn on/1s and turn off/1s for LEDs in Figure 4 [3].
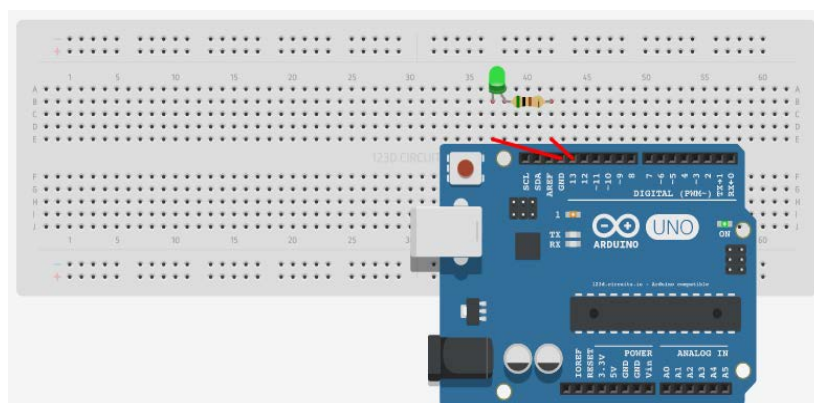

Figure 3. *Model of an electronic circuit with LED, resistor (Arduino supply)*

```
1 (Arduino uno)  ⌄        ⬆  Upload & Run

1    //LED
2    int led = 13;
3    void setup() {
4        pinMode(led, OUTPUT);
5    }
6    void loop()  {
7      digitalWrite(led, HIGH);
8      delay(1000);
9      digitalWrite(led, LOW);
10     delay(1000);
11   }
```
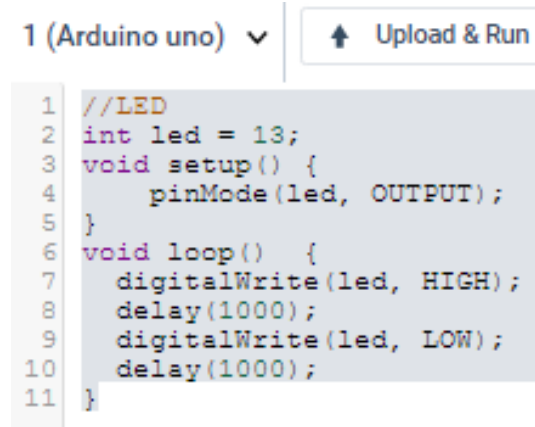
Figure 4. *Code for turn on/off (after 1s) LED*

Example for modeling traffic light is shown in Figure 5.
Code for same model is presented in Figure 6. On the traffic light model/determining the time regime turned on/off lights (red, yellow, green) by the parameters of the traffic light signaling (Code/Editor) and receive direct appropriate responses.
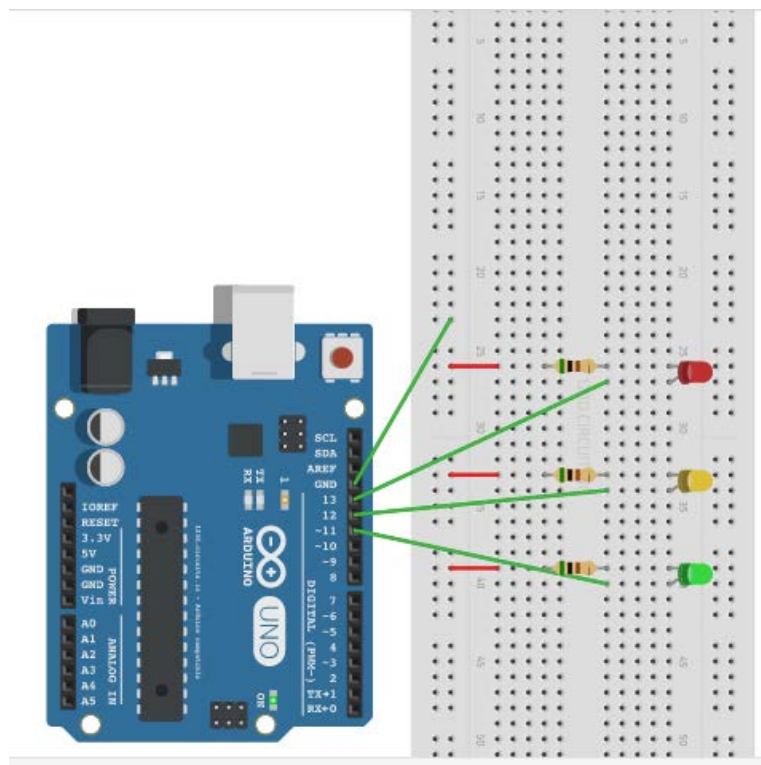Details of writing codes in Arduino are given in [4].

Figure 5. *Traffic Light Model*

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```
1 (Arduino uno)  ⌄        ⬆ Upload & Run

 1
 2  void setup() {
 3    pinMode(11, OUTPUT);
 4    pinMode(12, OUTPUT);
 5    pinMode(13, OUTPUT);
 6  }
 7  void loop() {
 8    digitalWrite(13, 1);
 9    digitalWrite(12, 0);
10    digitalWrite(11, 0);
11    delay(3000);
12    digitalWrite(12, 1);
13    delay(1000);
14    digitalWrite(13, 0);
15    digitalWrite(11, 1);
16    delay(3000);
17    digitalWrite(12, 1);
18    digitalWrite(11, 0);
19    delay(1000);
20  }
21
```

Figure 6. *Code for model control traffic light*

In the Electronics Lab is possible to create traffic light model/with determination time regime turned on and off lights (red, yellow, green). Certainly parameters/when light traffic signs easy to change (Code/Editor) and receive direct appropriate responses.
Figure 7 gives the 7-segment LED display model, which allows the display of numbers from 0 to 9. The complete code for the control of regime occurrence numbers (1s interval) is shown in Figure 8.
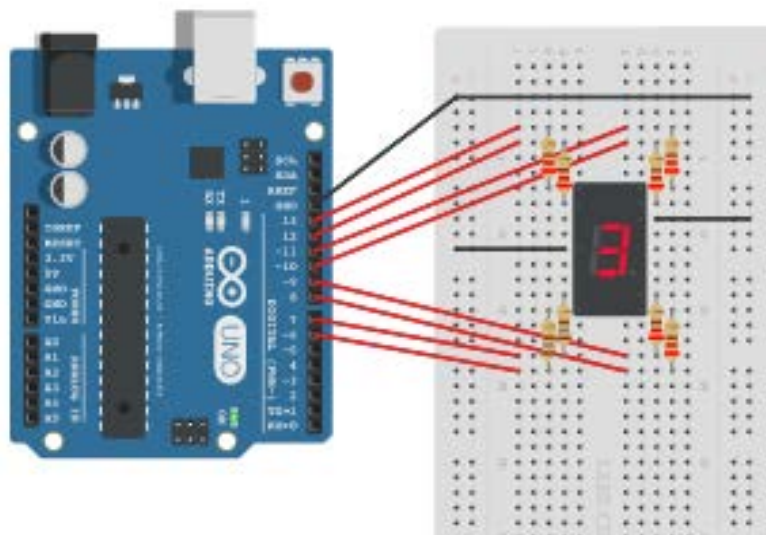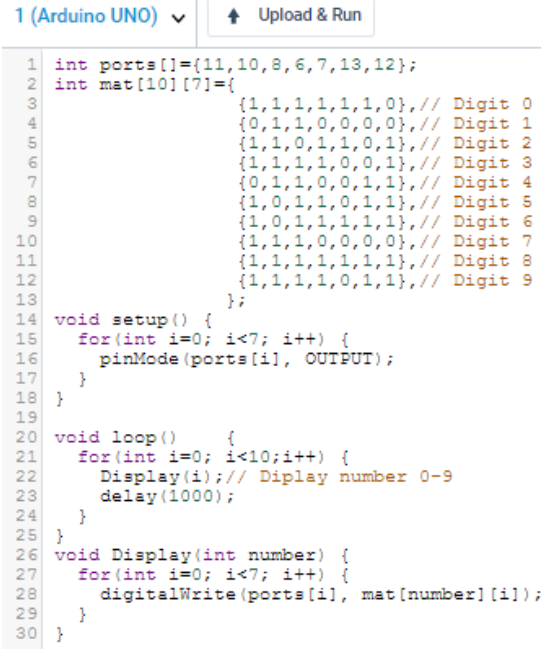

Figure 7. *Model LED Display (7-Segment, Digit 0-9)*

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```
1 (Arduino UNO)  ∨          ⬆ Upload & Run

1   int ports[]={11,10,8,6,7,13,12};
2   int mat[10][7]={
3                    {1,1,1,1,1,1,0},// Digit 0
4                    {0,1,1,0,0,0,0},// Digit 1
5                    {1,1,0,1,1,0,1},// Digit 2
6                    {1,1,1,1,0,0,1},// Digit 3
7                    {0,1,1,0,0,1,1},// Digit 4
8                    {1,0,1,1,0,1,1},// Digit 5
9                    {1,0,1,1,1,1,1},// Digit 6
10                   {1,1,1,0,0,0,0},// Digit 7
11                   {1,1,1,1,1,1,1},// Digit 8
12                   {1,1,1,1,0,1,1},// Digit 9
13                   };
14  void setup() {
15    for(int i=0; i<7; i++) {
16      pinMode(ports[i], OUTPUT);
17    }
18  }
19
20  void loop()    {
21    for(int i=0; i<10;i++) {
22      Display(i);// Diplay number 0-9
23      delay(1000);
24    }
25  }
26  void Display(int number) {
27    for(int i=0; i<7; i++) {
28      digitalWrite(ports[i], mat[number][i]);
29    }
30  }
```

Figure 8. *Code for control of the LED display*

4. CONCLUSION

Application Electronics Lab/123D CIRCUITS in teaching technics materials has multiple significance. Content and features it provides access to continue with innovative computing technologies necessary for education. The advantage of this so to speak electronic lab is that it is easier and faster to connect electrical circuits with virtual instead od real components. Available online or with a small necessary resources, the application becomes a tool for high-quality processing of lessons from Electrical installations and Digital electronics. The examples of the model electronic circuits clearly indicate the views of control and simulation models of typical LED, traffic lights and displays. At the same time the combination of development and simulation models, control and testing software codes in real-time proved to be a very significant and innovative research.

It is expected that motivation and interest of students to work in the Electronics Lab with all specifications indubitably would be at a high level. The application provides interactive and relevant cooperative relationship individual/in team for more complex projects, and is in the line with the learning outcomes in order to obtain relevant and necessary knowledge, skills and competences for further education at higher levels.

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