Implementation of an Arduino controller for temporary traffic regulation in one lane with semaphores

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Abstract. The purpose of this article is to present the use of an Arduino controller for a road semaphore to regulate traffic in directions in one lane. An Arduino starter kit is used. The electronic scheme, the bread board connection with Arduino UNO R3 and the programming code are given. This Arduino example may be adapted easily. All road repair companies may use this scheme to control the direction of one-way traffic in one lane. They may change the given source code with extended functionality

Key words: transportation, road repairs, Arduino IDE, Arduino UNO R3, programming, source code

1. Introduction

Road repairs sometimes need the use of temporary semaphores to regulate one way traffic in two directions in one lane. Traffic jams may occur. The use of one lane for two directional traffic sometimes requires two people to synchronize themselves and regulate the traffic. Improvements in this sphere may be given. The use of Arduino in many spheres of life is crucial. Road traffic and its importance for security reasons is clear. An Arduino controller may control the traffic with minimal personal management or with automatic management.

2. Literature review

Problems concerning “big data” are actual nowadays (Dogaru, Brandas and Cristescu, 2019; Kuyumdzhiev, 2020). Previous years the scope of the term was in the focus of many articles. Nowadays the methods for storing and organizing big data are actual. The difference between big data and conventional datasets sometimes is vague. A comparatively big dataset may become a comparatively small “big data” (Todoranova and Penchev, 2020). The border between big datasets, data warehouse and big data are clear (Todoranova *et al.*, 2020).

Business processes generate data. These data are usually stored in databases (Raychev, 2020). But in some cases databases grow larger and larger within several minutes (Nacheva *et al.*, 2019). In these cases, companies are migrating from databases to “big data”. The increased amount of data opens new perspectives for hardware storage (Nacheva and Sulova, 2021) and measuring the disk storage performance (Cristescu, 2019; Mishra, Polkowski and Mishra, 2020). Digitizing more and more business processes means that data are increasing (Marinova, 2016; Marinova *et al.*, 2016; Stoyanova, 2020). More energy is needed for their storage and cooling. Sometimes data centers are used. The question concerning the choice “own data center” or “using a 3PL” is open.

Storing large amount of data needs the application of mathematical methods for creating forecasts with big data (Miryanov and Yordanova, 2017; Nikolaev, Milkova and Miryanov, 2018a, 2018b; Sergeev *et al.*, 2020). Retrieving data has many approaches (Pólkowski, Prasad and Mishra, 2021). Creating forecasts with high reliability (Medvedev *et al.*, 2020) means accepting, testing and validating all assumptions for the chosen mathematical models (Miryanov and Petkov, 2017; Ana-Maria Ramona, Marian Pompiliu and Stoyanova, 2020; Stoyanov and Ivanova, 2021). Sometimes heuristic approaches are used for analyzing big data (Ileanu *et al.*, 2019; Polkowski *et al.*, 2020).

Providing web access to big data is another challenge with multiple technological solutions (Salem and Parusheva, 2018; Aleksandrova and Parusheva, 2019; Bankov, 2020). Creating software systems in many cases requires the use of patterns (Armyanova, 2019, 2020). But creating software with specific purposes with microcontrollers (such as Arduino) requires sophisticated knowledge in programming (Sulov, 2016; Stoyanov and Ivanova, 2019). Moreover, knowledge on software modelling is obligatory (Parusheva and Pencheva, 2022). Creating open software systems for many users have not only IT aspects, but also legal aspects (Czaplewski, 2018b, 2018a, 2018c; Czaplewski, Modzelewska-Stalmach and Popiołek, 2018).

3. The essence of the Arduino controller for semaphores

The idea of the semaphore is to control the traffic in one lane. At both ends of the lane a semaphore with 3 lights is installed (red, yellow and green). The change of the semaphores may be done with timer. But in this case study we have two push buttons at the end of the lane, so traffic workers may mane the semaphores easily – just with one press of the button. The electric scheme is the following (fig. 1)

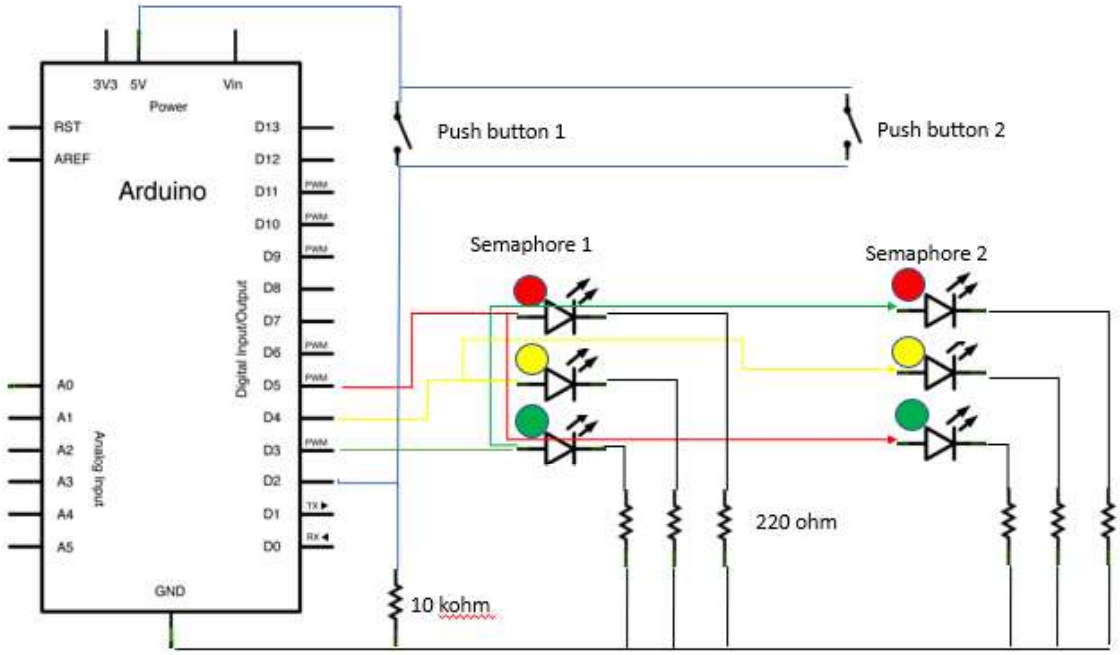

Figure 1. Electric scheme of the Arduino controller
Source: Own elaboration

The electric scheme is created in Power Point (within Office 365). The real implementation is with Arduino UNO R3 controller. An Arduino starter kit is used. The kit consists of a bread board, Arduino UNO R3 controller, resistors, LEDs (with different colours). The used elements are visible in the electric scheme. LEDs are used. In field work of the controller, the LEDs have to be changed by powerful resistors or relays which operate the lights of the semaphores. The left GREEN light is in parallel with the RED right light. The left RED light is in parallel with the GREEN right light. So there is no situation when both green lights are ON. When one GREEN light is ON, on the opposite site RED light is ON. This connection of wires guaranties normal one-way traffic. YELLOW lights are in parallel. The two push buttons are connected in parallel, too.

The bread board looks in the way (fig. 2).

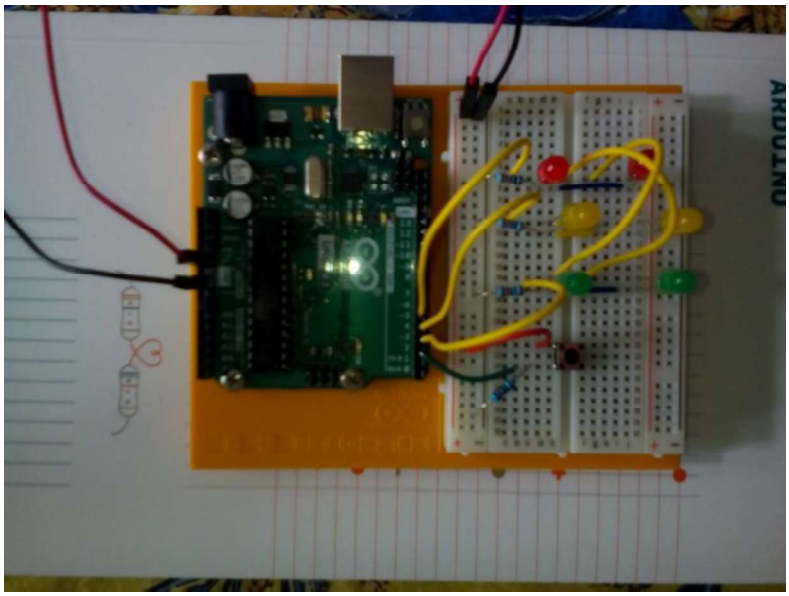

Figure 2. Electronic elements on the bread board
Source: Own elaboration

The initial state is when the semaphore on the left side of the lane is red, and the semaphore on the right side of the lane is green. Cars and vehicles may move only from right to left.

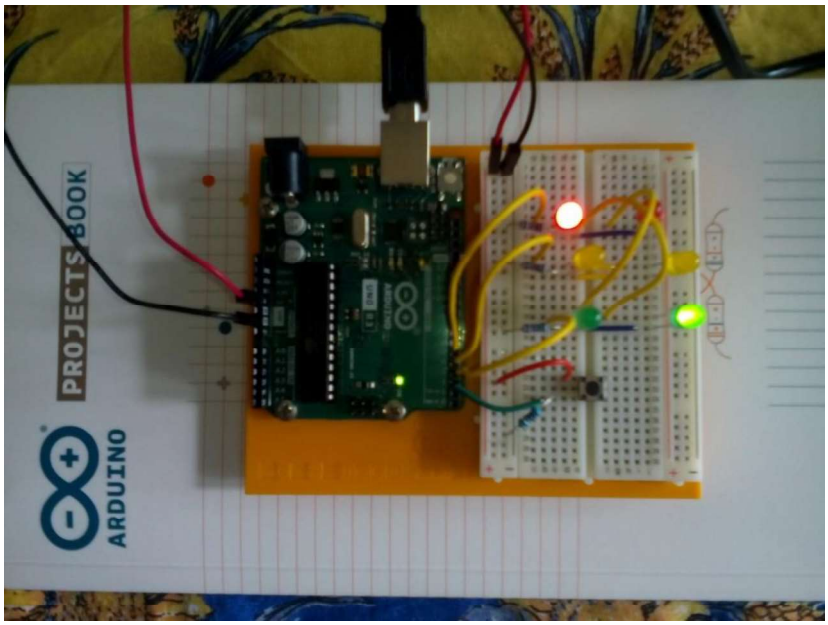

Figure 3. Electronic elements on the bread board – vehicles may move from right to left
Source: Own elaboration

The next state of the semaphore is when the traffic flow has to be changed. The two YELLOW LEDs are ON.

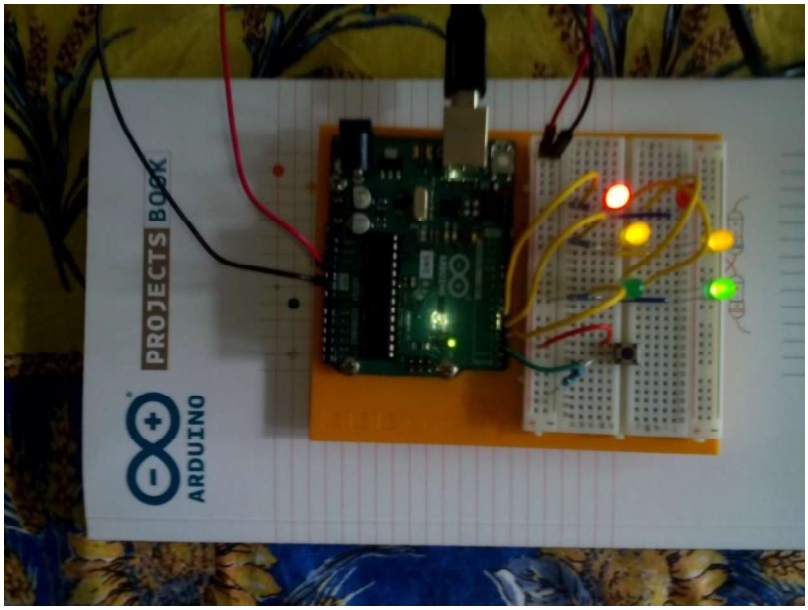

Figure 4. Electronic elements on the bread board – changing the traffic. YELLOW lights are on
Source: Own elaboration

The next step is to change the flow – left to right is allowed.

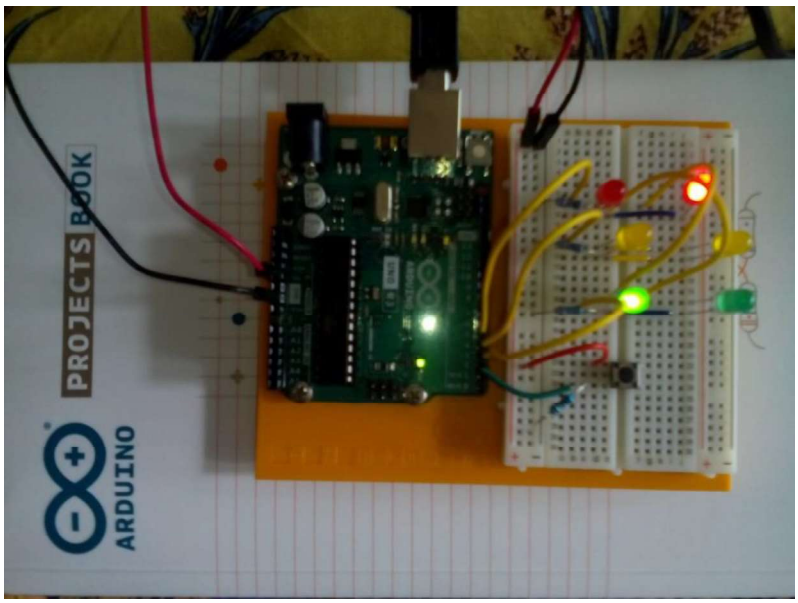

Figure 5. Electronic elements on the bread board – left to right movement of vehicles is allowed
Source: Own elaboration

The programming code is as follows.

```
int switchState = 0; // flag if on of the buttons is pressed
int jDelay = 2000; // delay for the YELLOW light. Now it is 2 seconds. It may be changed.
int SemaphoreState = 2; // The state of the semaphore
// 0 – without change
// 1 - from RED (left semaphore) to GREEN (left semaphore)
```

```
// 2 - from GREEN (left semaphore) to RED (left semaphore)
// 3 - GREEN light (left)… Connected in parallel with RED light (right)
// 4 - RED light (left)… Connected in parallel with GREEN light (right)

void setup() {

 pinMode( 2, INPUT ); // The second pin is input (for the push button)

 // The third pin is output
 pinMode( 3, OUTPUT ); // GREEN left light

 // The forth pin is outpt
 pinMode( 4, OUTPUT ); // YELLOW light

 // The fifth pin is output
 pinMode( 5, OUTPUT ); // RED light (left)

} // setup

void loop() {
 // From RED (left semaphore) to GREEN (left semaphore)
 if ( SemaphoreState == 1 ) {
  digitalWrite( 4, HIGH ); // The YELLOW light is ON
  delay( jDelay ); // delay
  digitalWrite( 4, LOW );  // The YELLOW light is OFF
  //
  digitalWrite( 5, LOW );  // The RED light (left semaphore) is OFF.
  digitalWrite( 3, HIGH ); // The GREEN light (left semaphore) is ON
  delay( jDelay ); // delay
  SemaphoreState = 3;
  } // if

 // From GREEN (left semaphore) to RED (left semaphore)
 if ( SemaphoreState == 2 ) {
  digitalWrite( 4, HIGH ); // The YELLOW light is ON
  delay( jDelay ); // delay
  digitalWrite( 4, LOW );  // The YELLOW light is OFF
  //
  digitalWrite( 5, HIGH );  // The RED light (left semaphore) is ON.
  digitalWrite( 3, LOW );   // The GREEN light (left semaphore) is OFF
  delay( jDelay ); // delay
  SemaphoreState = 4;
  } // if


 // The button state is read (from second pin of Arduino)
 switchState = digitalRead( 2 );

 // If the button is pressed
 if ( switchState == HIGH ) {
  if ( SemaphoreState == 4 ) { // If it is RED light on the left, we make a change from RED (left semaphore) to GREEN (left semaphore)
   SemaphoreState = 1;
  }
  if ( SemaphoreState == 3 ) { // If it is GREEN light on the left, we make a change from GREEN (left semaphore) на RED (left semaphore)
   SemaphoreState = 2;
  }
```

```
  } // if switchState

} // loop
```

Figure 6. Code listing in the Arduino IDE
Source: Own elaboration

4. Conclusion

As a result of this research several conclusions may be made.

The article presents the use of an Arduino controller for a road semaphore to regulate traffic in directions in one lane. An Arduino starter kit is used. The electronic scheme and the programming code are given. All road repair companies may use this scheme to control the direction of one-way traffic in one lane. Further development of the paper includes adding sensors counting the tale of waiting vehicles and automatically regulating the change of lights – the change of vehicles flows.

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