

STUDY OF AN ACCESS CONTROL SYSTEM USING AN OPEN SOURCE ELECTRONIC PROTOTYPE PLATFORM

ESTUDO DE UM SISTEMA DE CONTROLE DE ACESSO UTILIZANDO UMA
PLATAFORMA DE PROTOTIPAGEM ELETRÔNICA OPEN-SOURCE

ESTUDIO DE UN SISTEMA DE CONTROL DE ACCESOS UTILIZANDO UNA
PLATAFORMA DE PROTOTIPOS ELECTRÓNICOS DE CÓDIGO ABIERTO

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ABSTRACT: This article sought to present a study of an electronic lock system with a password using an open-source software and hardware electronic prototyping platform, that is, without any obstacle related to patents and generally relatively low cost. The motivation for this work is due to the fact that we are looking for a low-cost open-source solution for an efficient access control system, a system with functions to guarantee the ability to control, monitor and restrict the movement of people, being an essential security method and can be used anywhere. The methodology consists of approaching the functions of each component of this system and their integration, resulting in a demonstration by simulation with the assembly of the project, executing the opening and closing as planned. It concludes with the demonstration that the project is feasible, making it an incipient solution for others, such as robust safe systems or changing a pre-defined password for biometric access, using appropriate programs and components.

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Keywords: Arduino. Control. Access.

RESUMO: Esse artigo buscou apresentar um estudo de um sistema de fechadura eletrônica com senha utilizando uma plataforma de prototipagem eletrônica de software e hardware livres, ou seja, sem qualquer óbice com relações a patentes e geralmente de relativo baixo custo. A motivação para este trabalho se dá devido ao fato de se procurar uma solução de baixo custo e *open-source* para um sistema de controle de acesso eficiente, sistema este com funções de garantir a capacidade de controlar, monitorar e restringir a movimentação de pessoas, sendo um método de segurança essencial, podendo ser utilizado em qualquer local. A metodologia consiste na abordagem das funções de cada componente deste sistema e a integração destes, tendo como resultado uma demonstração por simulação com a montagem do projeto, executando-se a abertura e o fechamento como planejados. Conclui-se com a demonstração que há a exequibilidade do projeto, tornando-o uma solução incipiente para outros, como sistemas de cofres robustos ou troca de senha pré-definida por acesso por biometria, utilizando-se programações e componentes adequados.

Palavras-chave: Arduino. Controle. Acesso.

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RESUMEN: Este artículo buscó presentar un estudio de un sistema de cerradura electrónica con contraseña utilizando una plataforma de prototipado electrónico de software y hardware de código abierto, es decir, sin ningún obstáculo relacionado con las patentes y, en general, con un costo relativamente bajo. La motivación de este trabajo se debe a que buscamos una solución de código abierto de bajo costo para un sistema de control de acceso eficiente, un sistema con funciones para garantizar la capacidad de controlar, monitorear y restringir el movimiento de personas, siendo un método de seguridad esencial que se puede utilizar en cualquier lugar. La metodología consiste en abordar las funciones de cada componente de este sistema y su integración, dando como resultado una demostración por simulación con el montaje del proyecto, ejecutando la apertura y el cierre según lo previsto. Se concluye con la demostración de que el proyecto es factible, convirtiéndolo en una solución incipiente para otros, como sistemas seguros robustos o cambio de contraseña predefinida para acceso biométrico, utilizando programas y componentes adecuados.

Palabras clave: Arduino. Control. Acceso.

INTRODUCTION

Access control is a very important method in protecting an environment or object, making it difficult for potential offenders to access the places where the system is adopted. It is a security tool widely used around the world, its functions are to guarantee the ability to control, monitor and restrict the movement of people, being an essential security method, and generally the solutions offered by specialized companies involve too much cost to construction of these systems. There are also several ways to carry out this control, from the use of passwords, badges, biometric access and among others. With this, several studies are developed in this direction.

This article aims to describe a project for password access control, such as an electronic lock, using an open-source technology, simulating a ratchet-type opening, as shown in Figure 1.

Figure 1 – Example of a ratchet access system.



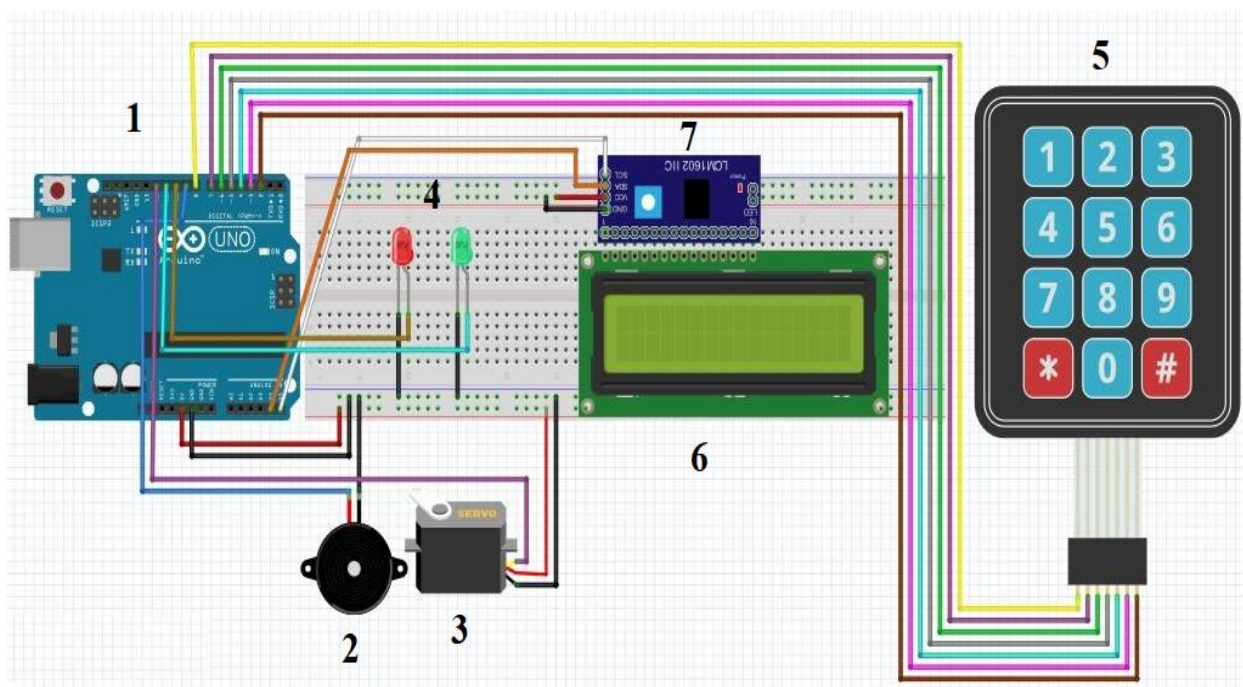
Source: CARDTEC, 2022.

In order to avoid obstacles related to patents, an electronic prototyping platform called Arduino is used as a control element. The Arduino is a microcontroller and some other electronic components mounted on a small printed circuit board with a serial interface for communication with a standard computer. On this board there are also some connectors where other external circuits can be connected, such as sensors, leds, switches, relays, and small motors (SILVEIRA 2011). In addition, all its data, from programs to schematics, are available on its website for free and forums were created for discussions about it (QUEIROZ, SOUSA, 2018).

METHODS

For the construction of the project, components that perform certain functions in the system are required and must be fully integrated with the programming. Figure 2 shows the representation of how these components interact and their characteristics are detailed in sequence.

Figure 2 – System Representation



Legend: 1 – Arduino Uno, 2 – Buzzer, 3 – Servomotor, 4 – LEDs, 5 – Keypad, 6 – LCD, 7 – Communication Module

Source: SANTOS RJ, 2022.

The main controller of the system is the Arduino, which consists of a microcontroller circuit board for the development of electronic prototypes, which allows the recording of a set of

instructions through a programming language in order to minimize complexities (FRIZZARIN, 2016). To use the programming language to create programs and record them on the board, it is necessary to use a development environment that supports this language and perform the necessary steps to compile and record it through an interface between the computer and the platform. To develop instructions and record them on the Arduino platform, an Integrated Development Environment - IDE must be used (QUEIROZ, 2018). It has a text editor that accepts the instructions and checks for syntax errors, a compiler to generate the file and a loader to send it to the platform. Figure 3 shows the IDE, which, through a microcomputer, has its programming transferred to the platform.

Another interesting factor is the use of libraries, which consist of a set of instructions developed to perform specific tasks related to a given device. The libraries have functions specifically designed to perform tasks such as setting the accelerometer, reading acceleration, gyroscope, temperature data, etc. and its use facilitates development, making the code simpler and more organized (MONK, 2010).

Figure 3 – Illustration of the Arduino Integrated Development Environment.

```

Arduino - 0011 Alpha
File Edit Sketch Tools Help
Blink
/*
 * Blink
 *
 * The basic Arduino example. Turns on an LED on for one second,
 * then off for one second, and so on... We use pin 13 because,
 * depending on your Arduino board, it has either a built-in LED
 * or a built-in resistor so that you need only an LED.
 *
 * http://www.arduino.cc/en/Tutorial/Blink
 */

int ledPin = 13;           // LED connected to digital pin 13

void setup()              // run once, when the sketch starts
{
  pinMode(ledPin, OUTPUT); // sets the digital pin as output
}

void loop()               // run over and over again
{
  digitalWrite(ledPin, HIGH); // sets the LED on
  delay(1000);                // waits for a second
  digitalWrite(ledPin, LOW);  // sets the LED off
  delay(1000);                // waits for a second
}

Done compiling.

Binary sketch size: 1098 bytes (of a 14336 byte maximum)
22
  
```

Source: QUEIROZ, SOUSA, 2018.

The buzzer's function is to emit distinct sounds for correct or incorrect passwords. It has a piezoelectric cell internally that vibrates according to the signal applied to its terminals, thus producing a sound. And this occurs because sound waves are produced by mechanical vibrations (FRIZZARIN, 2016).

The servomotor consists of a motor that presents a movement proportional to a command when it receives a control signal, checking the position at the moment of the command to control the movement to the desired position with the pre-established speed (SILVEIRA, 2011). Thus, it is the element responsible for activating what could be a ratchet or lock, performing the closing or opening.

A light-emitting diode (LED) is a semiconductor light source that emits light when current flows through it. The electrons in the semiconductor recombine with the electron holes, releasing energy in the form of photons. The color of light (corresponding to the energy of the photons) is determined by the energy required for electrons to cross the semiconductor band gap. When entering the wrong password, the red light is on and when the correct password is entered, the green light is on.

The input interface is exercised by the Keypad, which has 16 distinct buttons. The user will enter the numeric password in this component. There is a specific library for using this interface, making it easy to install with the controller.

The LCD display (Liquid Crystal Display) is responsible for displaying messages to the user. It is considered a visual interface for the user and has a specific library that facilitates its interface with the controller. This LCD display has 16 columns and 2 lines, with blue backlight and white lettering.

The communication module used I2C, specific to Arduino. The I2C module is used to communicate the alphanumeric LCD with the microcontroller, with this, it is possible to communicate the microcontroller with the alphanumeric LCD display using only the SCA and SCL pins. To connect the LCD display directly to the Arduino, six microcontroller pins are needed, with this module only two are needed (SMARTKITS, 2022).

With the components defined, the idea of how the system works is summarized as follows:

- 1- The system will have the access closed (turnstile on the right), with the text “Enter the Password” on the LCD display;
- 2- When entering the wrong password, the buzzer will emit a sound, turning on the red LED, displaying the text “Incorrect Password” on the LCD display, and will return to action 1; and
- 3- When entering the correct password, the buzzer will again emit a sound with a different tone to action 2, turning on the green LED, the text “Correct Password” will be

displayed on the LCD display, followed by “Open Door”. The ratchet will turn to the left and remain there for 5 seconds. After that, it will return to action 1.

RESULTS AND DISCUSSIONS

It is possible to obtain the results with the assembly of a system, simulating the operation of the access control with the described components, displaying on the LCD display the message “Enter the Password” – in portuguese “Digite a Senha” - (Action 1 – “Ação 1”). Therefore, when the password is incorrectly entered, the red LED lights up, displaying the message “Incorrect Password” –“Senha incorreta”, and the servomotor does not act on the ratchet (Action 2 – “Ação 2”). When the password is correctly entered, the green LED lights up, the message “Correct Password” (Senha correta) is displayed (Action 3 – “Ação 3”) and followed by “Open Door” (Porta Aberta) on the display and the servomotor will open the ratchet – it will be rotated by 180° (Action 4 – “Ação 4”). After that, the system returns to the initial state. Figure 4 displays these actions on the mounted system.

Figure 4 – Actions performed by the system.



Source: SANTOS RJ, 2022.

Analyzing the results and figures, it is possible to observe the basic construction of a system for simple access control using free software and hardware equipment. The ease of use and availability of a quality microcontroller also made a notable contribution. Obviously, improvements can be applied, for example, the introduction of other input interfaces, such as

optical or digital readers. The application of this study can be extended, serving as a basis for several other systems, such as safe projects, depending on the programming performed in its control software and inclusion of appropriate sensors and actuators, with potentially reduced costs by the use of open-source tools.

CONCLUSION

When observing an access control system, its importance, and the different ways in which it can be built is remarkable. The use of an open-source technology can make the construction of the main component more practical and low-cost, since there is no involvement with patents in this type of tool. The objective of this article is reached, due to the exhibition of the study of an access control with this technology, simulating a ratchet-type opening with a pre-defined password. Regarding the result obtained with the demonstration, it is concluded that the project is feasible, making it an incipient solution for others, such as robust safe systems or exchange of pre-defined passwords for access by biometrics or cards, using programming and suitable components.

REFERENCES

CARDTEC. 2022. Cancelas automáticas para controle de veículos. Disponível em: <https://cardtec.com.br/cancelas-automaticas-para-controle-de-veiculos/>. Acesso em: 6 fev.2022.

FRIZZARIN FB. Arduino: Guia para colocar suas ideias em prática. São Paulo: CASA DO CÓDIGO, 2016; 255p.

MONK S. Fritzing for Inventors: Take Your Electronics Project from Prototype to Product. Editora: McGraw-Hill Education Tab, 2015; 240p.

QUEIROZ WRO, SOUSA WQ. A importância da plataforma arduino no meio acadêmico. Revista Científica Multidisciplinar Núcleo do Conhecimento. Ano 03, Ed. 08, Vol. 12, pp. 123-133, 2018. ISSN: 2448-0959.

SMARTKITS. 2022. Modulo Serial I2c. Disponível em: <https://www.smartkits.com.br/modulo-serial-i2c-para-displays-lcd>. Acesso em: 6 fev. 2022.

SILVEIRA JA. Experimentos com o Arduino. 1. ed. Editora Ensino Profissional, 2011; 242p.

WIKIPEDIA. 2022. Light Emitting Diode. Disponível em: https://en.wikipedia.org/wiki/Light-emitting_diode. Acesso em: 6 fev.2022.