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BIOMETRICS DEVICE FOR HOME SECURITY

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Abstract: Thinking about ways to increase security in homes, a low-cost, efficient and independent biometric reader was created, easy to implement and without any buttons to use, making the entire system intuitive and easy to operate. An automatic registration and removal system were implemented, where only the owner of the device could register, in addition to having an external battery, keeping the device working even if the local power goes out, the device has a wide variety of applications, being used both for homes and for a small business. Its main advantage in terms of security is that its entire system is offline, making it very difficult to be hacked by another device, in addition to maintaining a history of all biometrics accessed and registered.
Keywords: Security, Biometrics, Arduino, Automation

INTRODUCTION

One of the biggest concerns these days involving residential security is invasions by intruders, so we must find efficient and cheap solutions for security. However, the monitoring devices on the market are expensive or difficult to implement, requiring specialized people to install them and sometimes even operate them.

With this in mind, a low-cost, efficient, self-sufficient and easy-to-install alternative was created for the user. The project consists of manufacturing a biometrics reader with Arduino that is easy to install and implement, independent, that is, without the need for a computer or other device, and can be placed on any electric gate, without the need to change the environment in which it is located. It will be installed.

Furthermore, the user himself will be able to install and configure the biometrics reader. It can also be installed in a small company. In this project we use a feature that consists of instant user registration and removal. At first, we register the main user, as the first registration, then this main user would have the autonomy to register the other users, after that we register a second fingerprint of this user, this fingerprint would correspond to the fingerprint authorized to remove others users. The screen contains all the necessary information to guide the user such as validating a fingerprint, or if the fingerprint is not recognized, in addition to providing guidance at the time of registration. The advantages of our reader are that the device does not have internet access and the codes are recorded in the Arduino itself, which converts all the code to hexadecimal and thus it is only possible to access the code through the computer on which the code was created, and only the main user can modify the registered fingerprints, another advantage is the low cost, both financial and implementation and maintenance, as the system is entirely made using Arduino and compatible sensors and the entire structure was printed using PLA material and a printer 3D.

Another advantage would be the security that biometrics brings, making it very difficult for someone else to use biometrics other than their own. A 10000-mA rechargeable battery was implemented next to the biometrics reader, which keeps our reader connected for approximately 6 consecutive days. Furthermore, the power cabling is located outside the device using USB cables, making it possible to connect via external routes and keep the device connected to the house's power supply. Another advantage of the battery is its use when the electricity in the house goes out, keeping the device on and working, as it is not necessary to use the internet for it to work.

Biometric security is divided into 5 categories ranging from 1 to 5 according to its quality of verifying biometrics and its veracity, the sensor used for the project was the DY-

50 which is at level 3, and this means that it has a 1 in 100 chance of rejecting a correct biometric and a 1 in 100,000 chance of it accepting a biometric that is not authorized by the system. By carrying out several tests it was possible to conclude that a level 3 system would be sufficient to bring security to a house and still keep the cost of the device low. Dealing with the security present in the system as a whole, upon receiving the code, the Arduino makes a conversion to hexadecimal and if someone wanted to have access to this code, it would be necessary to use a specific program and even with the code in hand it would not be possible. change it within the Arduino just by connecting the computer to the device, downloading the specific driver for that microcontroller used and even then, it would be necessary to know which port is being used to release the gate to open. In the Arduino NANO documentation, it provides examples of its use in the security area and finally, all the biometrics verification is not done in the Arduino processor, but in the DY-50 module itself, which is responsible for comparing and storing the fingerprints, just sending the validations and operating status to the Arduino.

The software takes an average of 3 seconds to start operating and start working, the interval between each user being able to enter their fingerprint is an average of 2 seconds and to carry out a new registration it will take at least 20 seconds of operation if the user follows all instructions correctly. The system has the capacity to store up to 162 fingerprints, one with authorization for registration and one for removal, however the number of fingerprints with authorization for registration and removal can be changed.

METHODOLOGY

ARDUINO

Arduino is an electronic prototyping board that allows the development of automation projects. It relies on open source technology, that is, it is open source, which allows access by anyone. It also has an IDE (Integrated Development Environment) for developing the software that will be inserted on the board to carry out the programmed activities (NOLETO,2021)

RELAY MODULE

The Relay consists of an electromagnetic switch that is used to turn on and off a circuit by a low-power electrical signal, or where several circuits must be controlled by a single signal (MARQUES,2019). The relays are named with designation, in the case of this work the Single Double Pole Throw (SPDT) relay is used. This has a total of five terminals, of which two are the coil terminals and a common terminal is also included, which connects to any of the other two (MARQUES,2019)

DY-50 SENSOR

The DY-50's all-in-one fingerprint sensor will make adding fingerprint detection and verification super simple. These modules are typically used in safes - there is a high-power DSP chip that does the rendering, calculation, feature localization and image searching. Connect to any microcontroller or system with TTL serial and send data packets to take photos, detect prints, hash and search. You can also register new fingers directly - up to 162 fingerprints can be stored in the built-in FLASH memory.

BLUETOOTH SENSOR HC-06/ HC-05

The HC-05/HC-06 is a Bluetooth sensor that aims to communicate wirelessly between the Arduino and a device with Bluetooth, which could be an Arduino itself. When using two Arduino to communicate via Bluetooth, one is called and coded as a servo and the other as a master, the first with the objective of receiving the data and the second for sending.

SD CARD READER MODULE

This Module is used to read and write to an SD card, with support for the official Arduino library. It is compatible with cards formatted in FAT32 with a capacity of up to 4GB. It can be used to store history of input values or data logging, values from GPS modules, temperature sensors, distance, humidity and luminosity, etc.

REAL TIME CLOCK MODULE RTC DS3231

The DS3231 Real Time Clock RTC Module is a high-precision, low-power real-time clock (RTC). The module has a built-in temperature sensor and also has a crystal oscillator to increase its accuracy. It is capable of providing information on hours, minutes, seconds, day, date, month and year.

ESP 8266

The ESP8266 Module is a microcontroller chip developed by the Chinese company Espressif. Because it has integrated Wi-Fi, this chip arrived to revolutionize the maker market and facilitate applications with IoT projects, due to its technical characteristics and affordable price.

Image: Esp. 8266

PROJECT

The project began with the aim of bringing technology, comfort and security to my home. Even though the Arduino is a prototyping board, when made carefully it has a long life and high performance. The device was designed in such a way that with just a few instructions any user could install it and put it into operation. The device has an Arduino® Uno; an LCD display 16x2 (5V); a DY50 biometric reader; a Relay Module (5V) - 1 Channel, a micro SD card module, a DS1307 clock module, Jumper cables to make connections and two breadboards to assist with cabling and reduce the chance of short circuits, in addition to bringing organization to the cabling.

It works using code created on the Arduino platform itself using a language called Wiring, similar to the C language and the Adafruit-Fingerprint-Sensor-Library library was used as a basis. One of the objectives is to remove all the buttons and still remain autonomous to avoid both handling errors and creating confusion when handling it. To this end, we installed a system that allows registration and removal to be done by the user responsible for the security of the house and if the gate does not have anyone registered yet, the program starts in a registration area, with this first registration being the only one. allowed to make new registrations and after that the user will be able to make a second registration that will allow them to remove fingerprints. As the Arduino does not have a memory system, it was necessary to search the code

to see which biometrics were last registered and so the registrations would continue from that moment on. If the biometrics module presents a problem, either due to misuse or due to age, it is possible to connect it to the computer and the Arduino IDE serial monitor will show which part of the device is not working correctly, whether in reading the biometrics, during registration or even when recognizing the biometrics sensor, it is also possible to see which biometrics are accessing the device via the serial monitor, however this digital is converted into hexadecimal and this information can be removed to avoid the risk of someone accessing this serial monitor.

When the project was created, it did not have a box to place it, keeping all the wires and components exposed and in this state, the device became very unstable, both because of poor contact and the difficulty of handling as shown in the photo, after this, a first model of the box was made, which was soon discarded as it did not meet all the necessary characteristics to make the system intuitive and easy to use; finally, the final model was made. The finished box is 8.2 cm wide at the base, 12.7 cm high and 10.5 cm long. The box was designed in Sketchup and printed on a 3D printer, having 4 side entrances, two for cables of Arduino power, one for connecting the gate, and the other side on which the biometrics are positioned. On the front it has a monitor tilted at 45º to make it easier to read the instructions for the correct operation of the device, as we can see in the Figure below. The box has a door on the back, allowing the user to have easy access to all circuits both for maintenance and battery replacement and for charging the battery if necessary. The device does not have any nails or screws and therefore its maintenance becomes practical and can be carried out by any user even if they have no knowledge in the area.

Finally, the Arduino nano was replaced by an ESP 8266 due to its wi-fi module built into it, with it its own IP was created that would serve as a router and then a website was created with Html, CSS and Javascript informing the time that the RTC Module would provide, in addition to all information on the use of the device, such as authorization, registration, removal, among others.

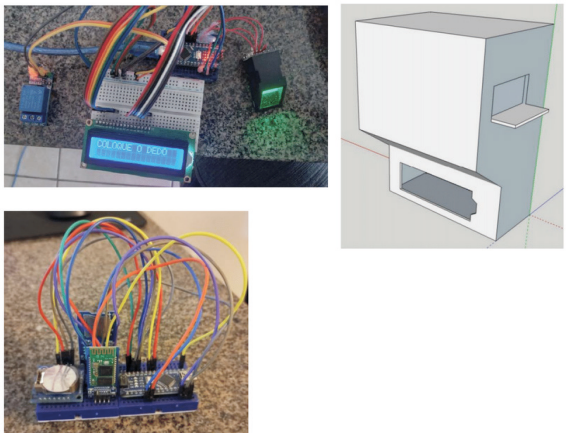


Photo: image of the project during assembly and testing

COST

With the device ready, research was carried out on where to find the sensors and the Arduino to find out when all the equipment would come out, as one of its biggest benefits would be its value and ease of implementation. Taking as references the prices found in applications that work with stores in China and other countries, the cost of all equipment is around 129.62 reais including the price of producing the box made with the 3D printer. The cost may also vary according to the quantity purchased, as the stipulated value only considers the purchase of a single unit of each of the components. For 3D printing, only the cost price of the material and light was considered, as it was printed on my printer, promotions and discounts were not considered in the calculations, only the closed prices.

	International	International	National	National	National
DY-50 biometric sensor	37,31	34,9	65,9	-	-
Arduino Nano	18,34	20,88	20	-	-
LCD 16x2	10,4	10,61	17,9	25	-
Jumper cables	7,5	-	13,36	8,18	9,18
Relay Module		-	9,9	8,99	12,03
3D printing		-	21,68	-	-
Power bank 10000 mA		-	29,88	24,49	25,98
Smallest cost	126,3				
Biggest cost	186,19				

Chart: Price table

PROCESS

The biometrics sensor initially worked, having to use several codes one after the other to register and operate it, after some changes the main code was able to read the biometrics registered on the device. The second implementation was registration in the main code itself with the instant registration functionality. However, any registered person could register a new biometric. To avoid risks, a parameter was set that only the chosen user could register new people, bringing more comfort and security to residents. After all the pinouts and the device was ready, a Relay module was implemented to connect the gate to the device and a 10000mA rechargeable battery. The Arduino would be powered by the battery and the gate would also use battery power to open it. After some calculations, it was found that the battery would be able to keep the Arduino powered on for 6 consecutive days.

We carry out all the cabling and for installation on the gate, we use two wires, a ground wire for the gate and the other to power it. For greater comfort and security, a new function was configured that would allow the main user to delete the last registered fingerprint, if the fingerprint was not registered correctly or if the user no longer wants that fingerprint to be authorized on the device.

So it was thought to place a Bluetooth module in the device and create a second system, an SD card module, a Bluetooth receiver and an RTC module were implemented in it, this second device would be located inside the residence and would have communication with the main device via Bluetooth, the secondary device would receive registration information from the device at the gate, such as the registration of a new fingerprint, the removal of a user, authorization or any error that could happen with the device, this system would then pick up the time at which the action happened and would store it on an SD card through a txt file, meaning that all the information would remain inside the house and whenever the user wanted to know about any access made to their house, they would be able to be aware of it through the txt, so such as the day and time of the incident. With this system, the user would have control over who is accessing the device, however the system would remain offline, keeping the system secure.

However, Bluetooth communication between two modules is not very stable, with this in mind, it was decided to exchange the Arduino NANO for an ESP 8266, and the same previous functions were implemented in it, but it would give access to a more intuitive web page with more functions. that using Bluetooth, in addition to reducing the cost of the device as there is no need to use a second device, also reducing the chance of pinout errors.

DISCUSSION

During the development of the project, some problems were encountered, mainly thinking about the resources that the devices found on the market have, the main one being the stability of the system and the size of the devices, the financial issue remained a positive factor of the project, however its size is larger

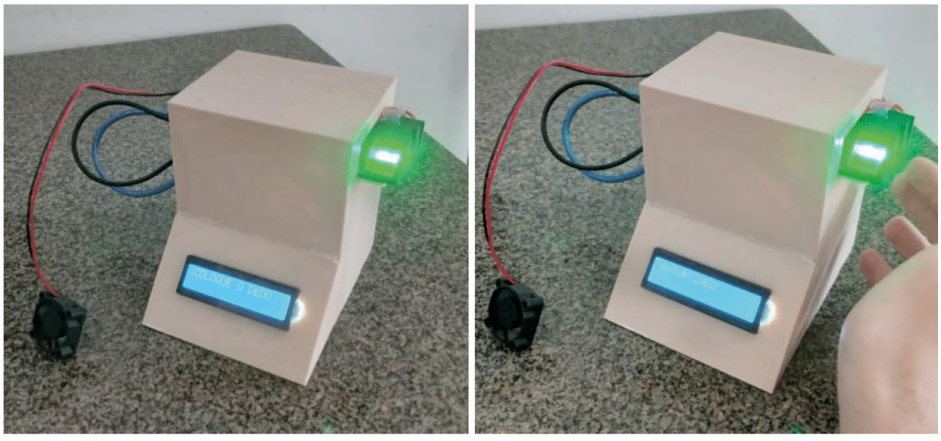
than that of the devices used as reference.

CONCLUSION

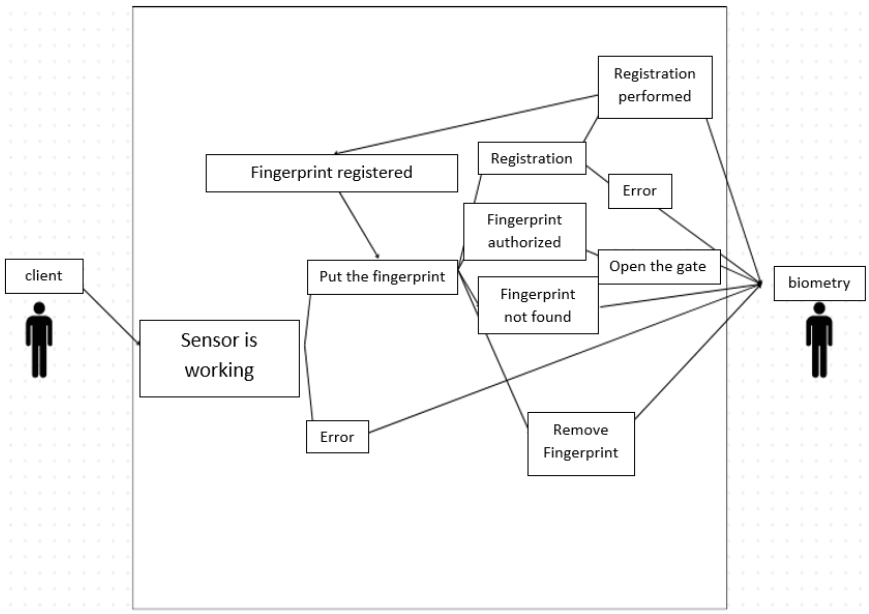
All objectives for the project were completed, from pinning to projection and printing of the box. This project is still in a prototyping format, however it is already possible to put it into operation, after much research it was found that its cost is below that of other biometrics devices in addition to having exclusive features that many do not have, such as self-sufficiency and ease of implementation and because it uses an Arduino board, the project can undergo updates without giving up its main security features. The next step is to transform it into a product through the use of a printed circuit board, reducing the possibility of errors due to handling since all devices would be soldered to the board, which would also reduce the number of wires, and could even reduce the size. of the device. Another implementation would be the creation of a cell phone application, that is, the implementation of an internet module, so that we can register with photo and name, in addition to giving the user control over who is passing through the sensor every time they are used. Thus, generating remote control for users to access the gate and to assist in registration, providing more information about people who have their fingerprint registered. Another limitation seen in the project was if the residence uses another biometric device, in this case, the user would need to register for both biometrics separately. This also becomes a problem for companies that normally have more than one turnstile or door, in addition to the limitation of 162 fingerprints that the device can store, which can cause some problems in medium-sized companies or if the company does not delete fingerprints that are not being used. With the change to ESP 8266, we thought about some future changes that would greatly help the user, namely, making an interactive and easy-to-use website, allowing registration through the website, in addition to maintaining the device and with the website, registration could be name, and may have direct information about who is using the device.

APPENDICES

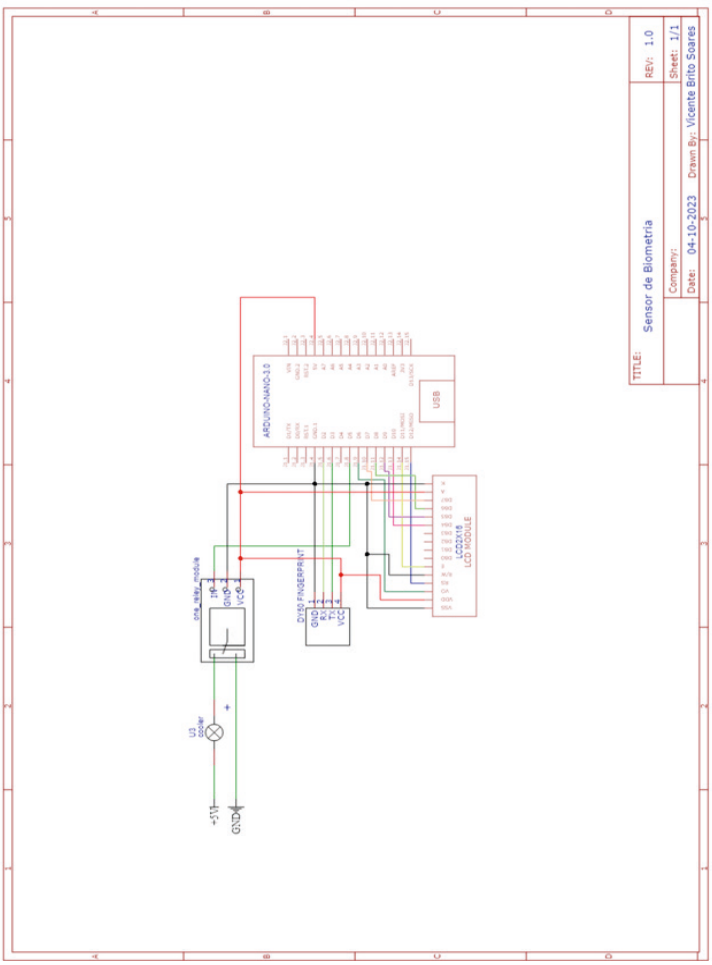
APPENDICES A



APPENDIX B - USE CASE DIAGRAM



APPENDIX C – CIRCUIT CREATED IN EASYEDA



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