QRCode DOOR Project: Access Control Application using QR Code Image

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Summary

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  - Benefit / Innovation
  - Main contribution
- **Methodology**
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- **Conclusion**

Introduction

✓ Project Definition

- The present research proposes a novel technology for door access control, creating a **smartphone** embedded key, making use of cryptography to generate a **QR Code image**, all this combined with a **WebCam** attached to an electric lock on **a door**.

Introduction

✓ Motivation

The creation of smart doors, which can be managed remotely and have a simple and modern activation interface.

✓ Benefit

This technology brings security to people, easy door management anywhere and personal use of your smartphone.

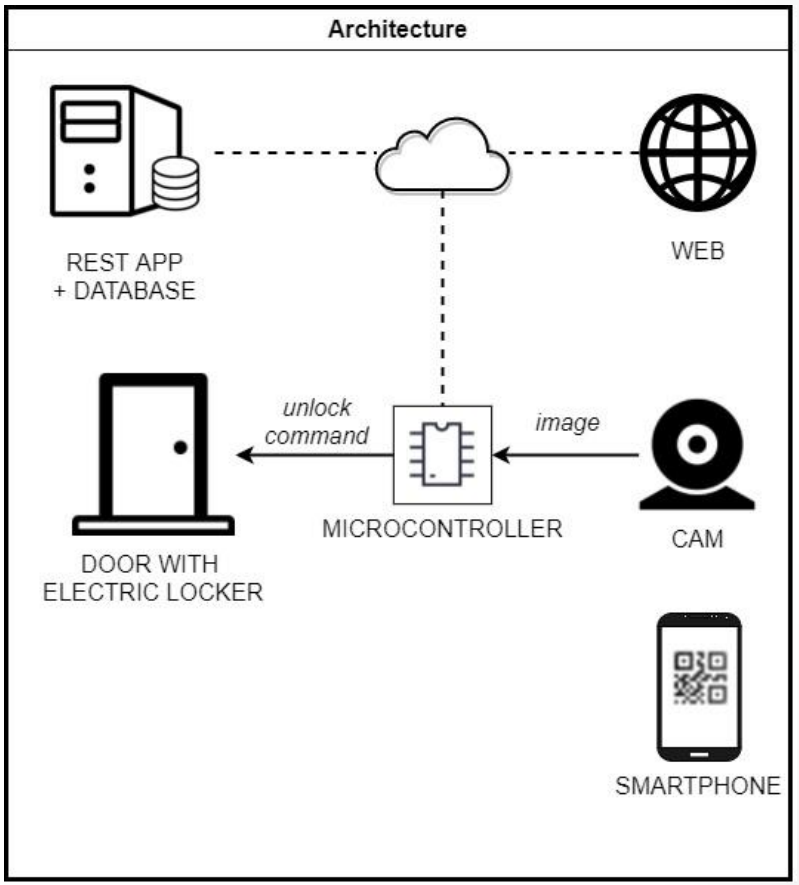
✓ Innovation

Using the encrypted QRCode feature to access ports and the mobile environment.

Introduction

The **main contribution** of this research is a new computational tool for door access control in both environments:

- ✓ **Software**: conception and development of the web-client and mobile environment.
- ✓ **Hardware**: the creation of the access device, which involves the QR Code capture definition by the WebCam, using a controller board and embedded programming.



Methodology

The methodology uses an exploratory approach of observational and empiric procedures.

The system uses Java and JavaScript languages for the computer side and the Python language for communication between the micro controller and the computer.

First step:

- Web-client and mobile layout prototyping.

Second step:

- Creation of the access device, which involves the QR Code capture definition by the WebCam.

Third step:

- System architecture design, conceiving the integrated system.

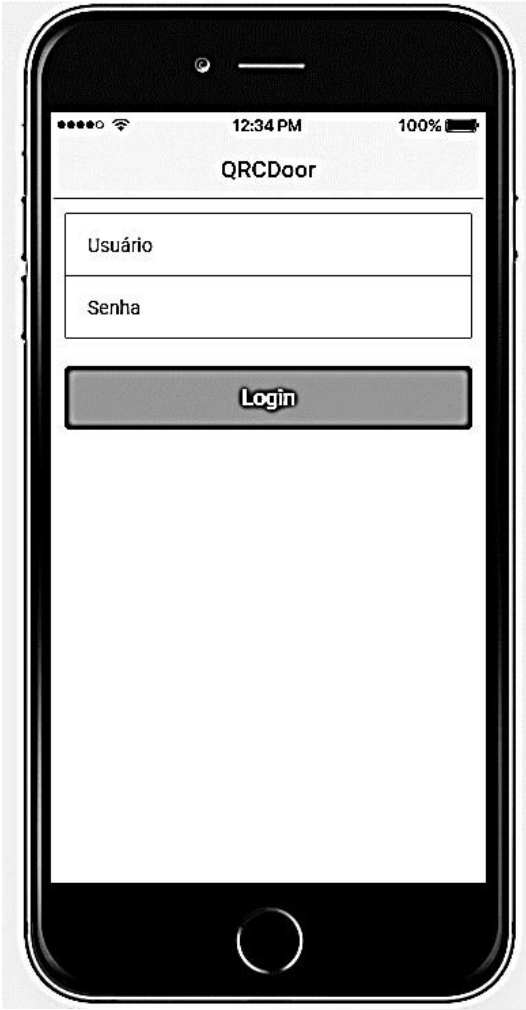
Fourth step:

- Validation and integration tests with a physical access device.

Methodology: 1 step

Web-client and mobile layout prototyping

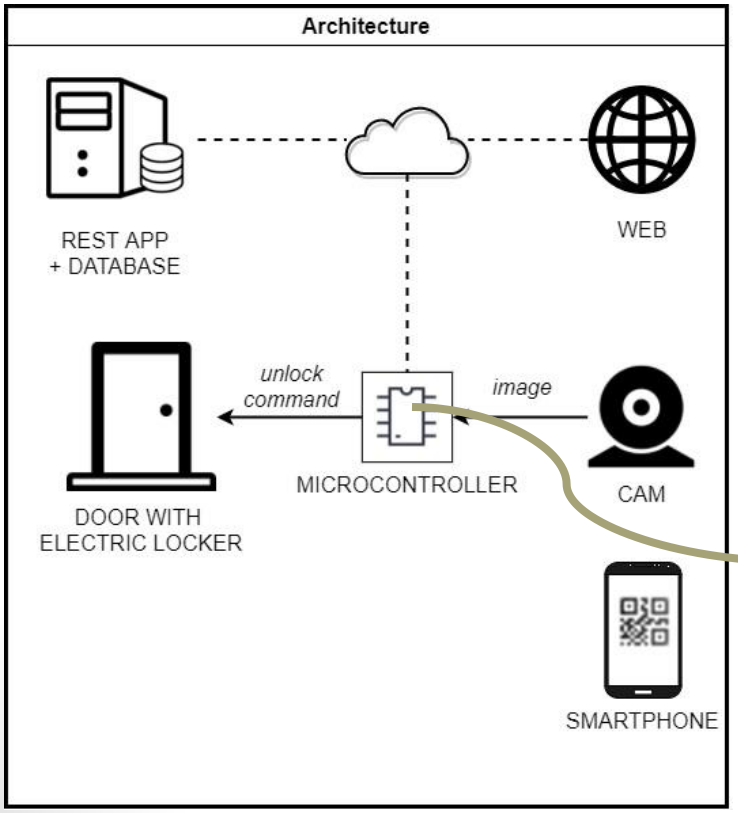
ergonomic design

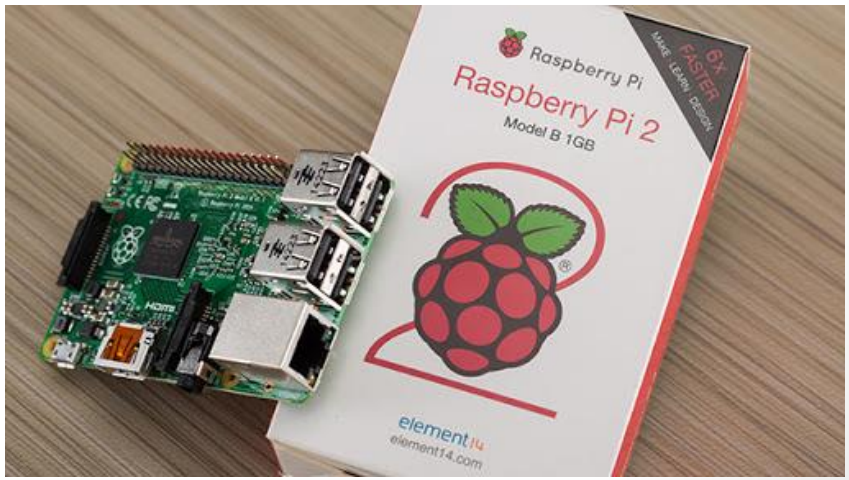


Methodology: 2 step

The access device creation

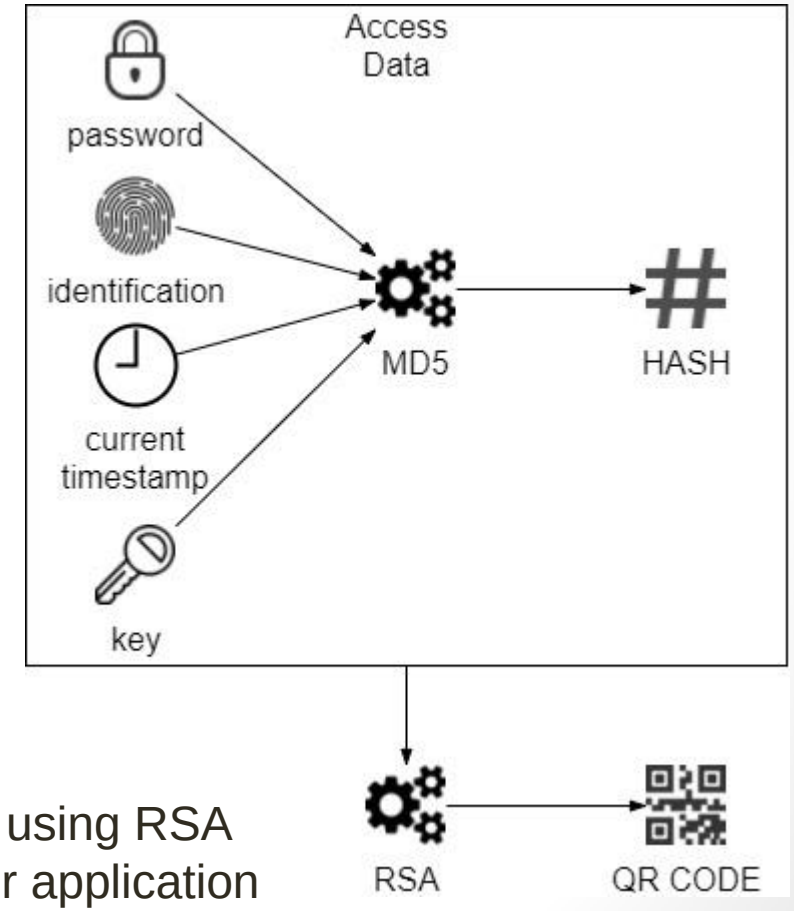
Access Control Device Conception:
The access control system is composed of an electric lock attached to a door and a Webcam that reads the QR Code from the smartphone's screen. These devices work-integrated through a Raspberry Pi 2 microcontroller.





Methodology: 2 step

The access device creation



QR Code Image Conception:
The QR Code is used for access information transmission from the smartphone to the access control system. These information contains the following items: the unique device identification; user's access password; a system generated key; the date and time of the QR Code generation; and a hash MD5 in order to avoid access information corruption.

Lastly, all these information are encrypted using RSA algorithm so that no QR Code reader other application is able to interpret this information.

Methodology: 3 step

System architecture design

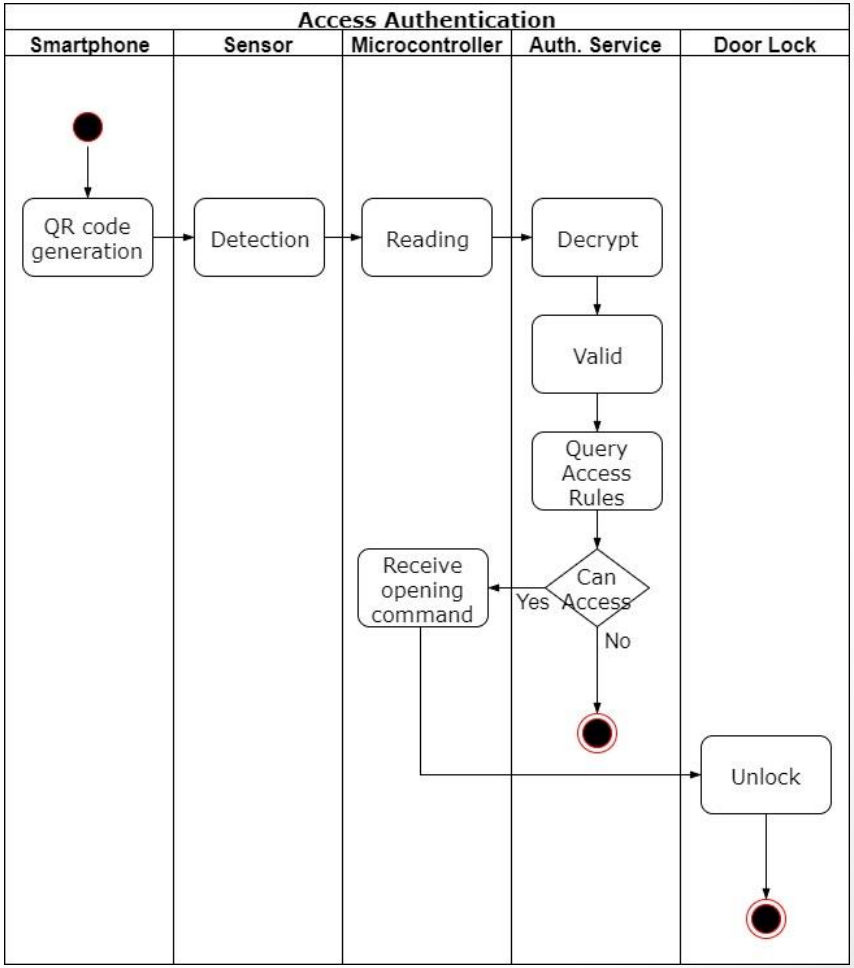
- Five artefacts were identified in the validation and access liberation process: an access key, a sensor, a client, and authentication service and a physical access device.
- The **key** is generated by the smartphone which generates the **QR Code** according the previously mentioned procedure.
- The **sensor** is a WebCam, positioned and e disposed in any user's arm's range.
- The digital camera is connected to the client and is responsible for smartphone produced QR Code reading and acquisition.
- The **authentication service** contains all the access rules and answers to all clients if an access is allowed or not.

Methodology: 3 step

The **authentication process** is configured in six steps, which are:

1. The application installed on the user's smartphone is responsible for creating and rendering the QR Code on its screen with the access information,
2. The user's QR Code is then, captured by the camera that transmits the image to the microcontroller.
3. Using image processing techniques on the user's QR Code, the microcontroller identifies the QR Code, reads its containing access information, and sends them to the authentication service.
4. The authentication service decodes the access information, validates the authenticity of the data, and checks within the access rules if the door must be opened or not.
5. In case the service identifies that the door must be opened, it sends the liberation request to the microcontroller attached to the door lock.
6. The microcontroller activates the door lock in order to open it.

System architecture design



Methodology: 3 step

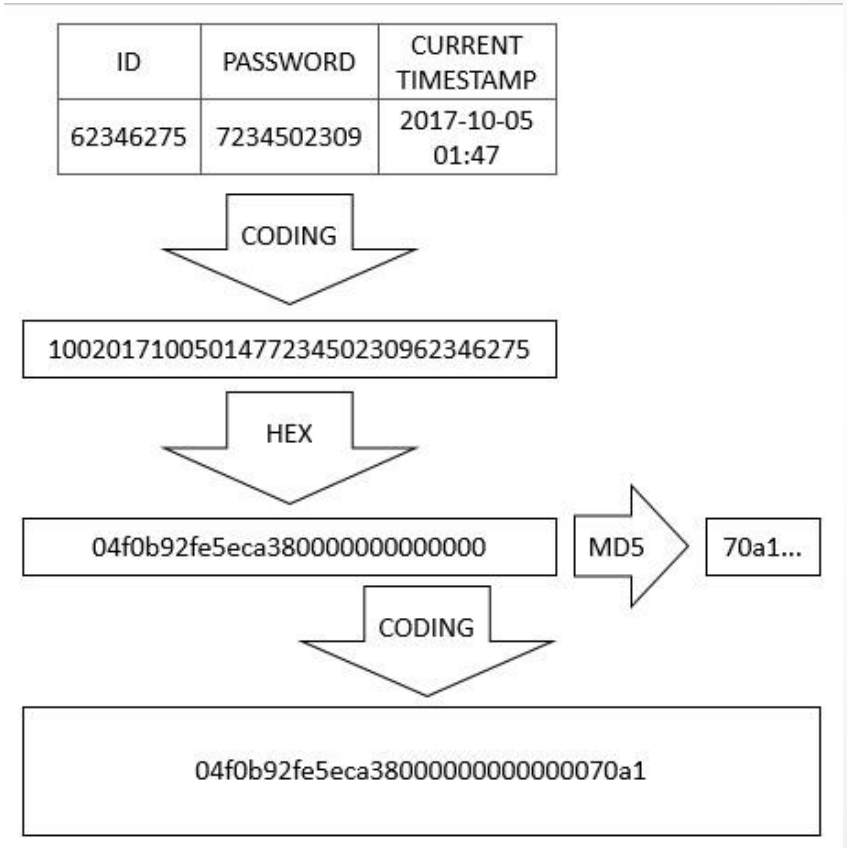
System architecture design

QR Code Image Generation

Concerning verifying the QR Code generation it is used unit test technique validating the system input and output.

We seek to find if it is possible to generate the QR Code inside the predefined security parameters:

1. Containing the basic authentication data, composed by device identification and password;
2. Containing date and time of QR Code generation;
3. Containing hash-based data to validate the information authenticity;
4. Encrypting all the data before the QR Code generation.

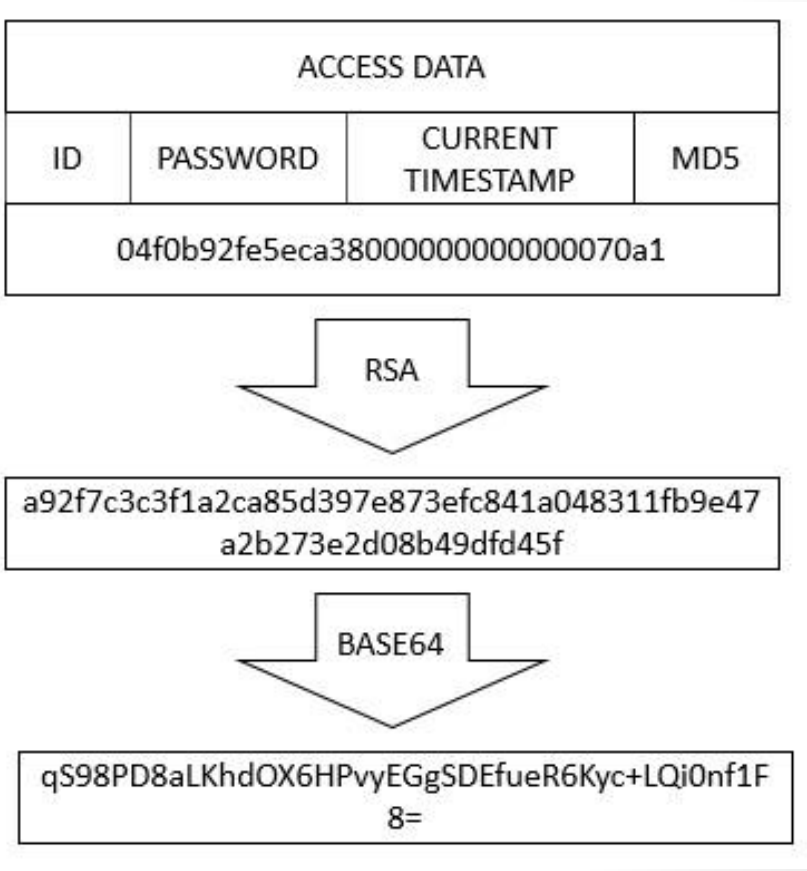


The MD5 algorithm is applied in the generation of a hash. Then, the first hash two bytes are concatenated at the end of the previously encoded data. This step is fundamental to the authentication service to verify if the access data hasn't been changed.

Methodology: 3 step

System architecture design

- Lastly, the data is encrypted with the RSA algorithm and encoded in base64.
- The encryption is necessary so that no other QR Code is able to interpret its containing information.
- The base64 encoding is necessary because the RSA output is a set of bytes and the QR Code is generated from a text.



Methodology: 3 step

System architecture design

Finally, the output is a QR Code image that can be easily read by the access control device and owns all the needed security characteristics of the project.

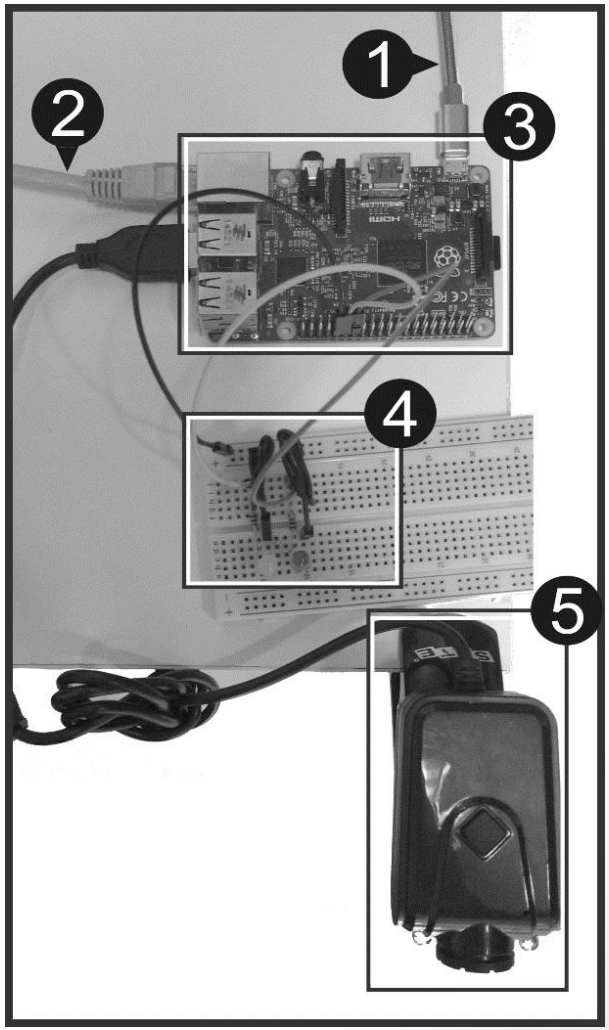
Methodology: 3 step

System architecture design

Hardware to Access Control

In prototyping, it is assembled a device to meet with the requirements. It is possible to identify the following components:

1. CC Power cable, 5 Volts and 2 Ampers with micro USB 2.0 type B connector (see 1);
2. Ethernet cable with RJ-45 connector, connected to the same network as the authentication service (see 2);
3. Microcontroller Raspberry Pi 2, with 900MHz processor, 2GB of RAM, e 8GB of ROM (see 3);
4. LEDs to indicate the system status of the door lock simulation system on a breadboard (see 4)
5. Digital camera with 5 Megapixels resolution connected via USB (see 5).



Methodology: 3 step

System architecture design

Hardware to Access Control

- The camera functioning and QR Code reading competence are checked by Zbar Barcode Reader, it highlights the captured QR Code image inside a light green rectangular area.
- The configuration and network connectivity with the authentication service is done with a shell Telnet command that verifies not only the network layer but also the application layer.
- And finally, the logic microcontrollers port verification is done by software, it is connected LEDs on microcontroller ports and executing a script written in Python language, using RPi.

Methodology: 4 step

Validation

- The **QR code generated** is rendered on the smartphone screen in front of the device's camera.
- The **access data** is then captured and sent to the server who decodes and validates if the access is allowed and returns an authorization message to the door lock, or in this experiment case, activating the LED.
- All these test data are obtained through the logs shown in the screen connected to the microcontroller.

Test

- Firstly, the device logins the server sending user data and password.
- Afterward, it opens a WebSocket connection to exchange messages referring to the door lock.
- As soon as it detects and extracts the access data from the QR Code, the system sends information to the server.
- And lastly, after the server decrypting and validating the data, it notifies the client that the door lock must be activated.

```
qrcdoor-embedded/src $ python3 main.py
Connecting to server by websocket
Creating session
URL: "http://192.168.1.3:8070/login"
PAYLOAD: "{'password': 'user1', 'username'
Sending data to server
Server's response
URL: "http://192.168.1.3:8070/login"
RESPONSE: "<Response [200]>"
Cheking session
URL: "http://192.168.1.3:8070"
RESPONSE: "<Response [200]>"
Session valid
COOKIES: "{'SESSION': '41341f27-4c60-41db-
URL: "ws://192.168.1.3:8070/open/websocket
COOKIE: "SESSION=41341f27-4c60-41db-9019-3
WS connection has been opened
Sending QR code:
QR-Code:Bzhshsjsjjdhhddjdjhdhdjdjxj
A message has been received:
Hello, QR-Code:Bzhshsjsjjdhhddjdjhdhdjdjxj
```

Conclusion

- ✓ In this paper, we propose using **simpler, cheaper, and consolidated technologies**, creating virtual embedded keys in smartphones.
- ✓ Controlling access is a present-day problem.
- ✓ The **QRCDoor innovates** making the control digital and embedding the access keys and cards in a smartphone. Making it possible to **create complex access rules** to places with **specific date and time** easy identification and access key control.
- ✓ This **research relevance** is that the proposed system makes daily life more practical for home and professional environments.
- ✓ This project is still **under development**, we are now using new features such as tags, temperature sensor, presence sensor, reports and improved user interface both on the web and on mobile.

Questions?

- Thank you very much!

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