

# Using an RFID card with a password to open a door

OUESSE Mohamed E. A., Baboucar DIATTA, Mohamed SALL and Adrien BASSE    Ridha BOUALLEGUE  
*Dept. of Information and Communication Technologies*    *Innov'Com Lab, Sup'Com*  
*Alioune Diop University of Bambey*    *Université de Carthage, Tunisie*  
Bambey, Senegal    Tunis, Tunisie  
omea82@yahoo.fr, baboucar.diatta@uadb.edu.sn,    ridha.bouallegue@gmail.com  
mohamed.sall@uadb.edu.sn and adrien.basse@uadb.edu.sn

**Abstract**—Security is of paramount importance in homes, schools, offices and industries. Traditional mechanisms such as locks and keys, door chains etc. have all shown their limitations. These limitations include: the key can break in the lock; the lock can be defective; the key can be stolen or fraudulently duplicated resulting in unauthorized access to a building. This article describes the development of a system to secure access to a building.

In this system, users who are authorized to access the building are identified by their radio frequency identification (RFID) card and authenticated by a password. This system provides an effective means of controlling the entry and exit of authorized persons, as well as preventing the entry of unauthorized users and reporting intrusion attempts.

To set up this project, we need to acquire a radio frequency identification (RFID) reader, an RFID module, an LCD screen, an ESP8266 MCU node, a database manager and a website.

**Keywords**—RFID, Password, Security, ESP8266

## I. INTRODUCTION

Home automation brings together technologies from electronics, automation, computing and telecommunications in order to provide technical solutions to meet the needs of user comfort, security and communication that can be found in public or private living and working places such as homes, hotels, businesses, shops and among others. Home automation not only opens up new possibilities in the field of home automation, but also provides a means for individuals to control and manage their environment. Thanks to this new technology, the occupant will be better able to manage his work and living environment in terms of safety, comfort, communications and household applications.

Currently, the most common way to open or close a door is the physical use of a metal key. But this mechanical system poses many problems because the keys can be lost, misplaced or broken and/or stuck in the lock.

With the digital revolution, more and more devices and objects of our daily life are becoming more intelligent, connectable to networks and controllable with a smartphone or thanks to sensors. Indeed, the evolution of technology now makes it possible to design work and housing spaces that are better suited both in construction and in revolution. These advances are made possible thanks to electronics and the new

design of communication networks both inside and outside homes.

One solution to solve said problems is the creation of an access system with an RFID card. This method will allow people with an access badge to open a door. Badges are interesting alternatives. However, another problem arises in that badges can be stolen; the purpose of this paper is to secure said RFID card.

## II. STATE OF THE ART

The smart home is one of several topics that have attracted significant research attention in recent years. Home automation allows the monitoring and automatic control of homes without human intervention [3], [4] and [5]. Indeed, home automation makes the house smart by allowing it to perform many functions, having a very important impact on the daily life, like the comfort, the energy efficiency, the safety and the environment. Domestic security being an important and fundamental aspect of comfort and fulfillment in the living environment, a lot of efforts have been made in research to propose solutions in the face of the increasing criminality and robbery rate. It is in this sense that many research works have proposed systems that allow identification by radio frequency (RFID) to secure and make the living environment more pleasant.

This is the case in [6] where a brief review of RFID systems was carried out. This review takes into account all the solutions both with chips and without chips. The authors of this work have presented a classification of the main types of sensors in the form of a diagram, and for each type of sensor, the principle of operation is presented and discussed. The paper also presents the main uses of radio frequency identification (RFID) sensors in case of Internet of Things (IoT). In [7], a system for identification and automatic authentication is proposed for deployment at the doors of every home, office, campus, and building to authenticate authorized persons. In the system, a gate lock can be managed by an RFID card. Radio Frequency Identification (RFID) represents a wireless solution for managing the access control system. This strategy not only lowers the cost but also improves the reliability and ease of use and maintenance of the authentication system. In [8], the authors propose a solution that improves the management of

home control and supervises all the house access points that are commonly susceptible to trespassers and burglars.

The suggested solution relies on person identification with the help of detection method and radio frequency identification (RFID) as a technique to improve the efficiency of house security systems. A remote server in the cloud is used to analyze and identify the person who wishes to have the authorization to get into the home. The proposed system records any unlawful intrusive activities at the house’s door or windows. In [9], the authors combined RFID systems and wireless sensors to leverage their benefits and overcome limitations to enable new applications in the scope of Internet of Things.

### III. PRESENTATION THE ESP8266 NODEMCU

#### A. Definition

The NodeMCU ESP8266 which is an Open Source programmable microcontroller with Arduino IDE and having an integrated Wifi module ideal for Connected Objects is an IoT platform, hardware and software, based on an ESP8266 WIFI SoC manufactured by Expressif System. Male and female side connectors allow modules to be inserted on the breadboard. The Wi-Fi wireless interface that allows the creation of wireless access point and the hosting of a server manages the sending and receiving of data on the Internet.

Thanks to this, it is possible to create a server which hosts a Web page making it possible to control the microcontroller remotely.

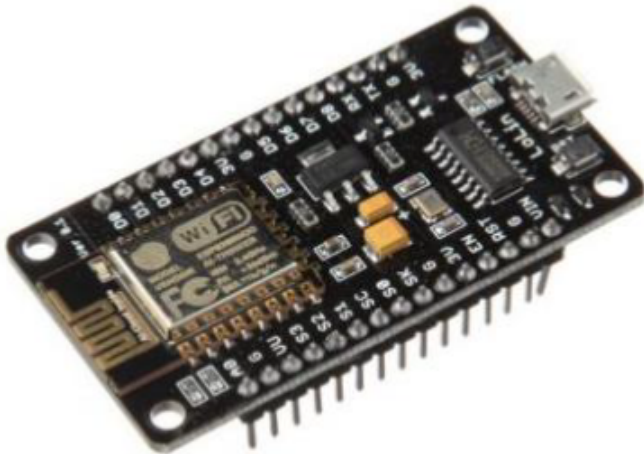


Fig. 1. NodeMCU

#### B. Principle of operation

The ESP8266 Node MCU contains an ESP-12 module containing a 32-bit microprocessor. It incorporates a Wi-Fi transceiver that allows it to connect to existing networks or to set up its own network.

The nodeMCU ESP8266 which is the solution of an autonomous Wifi network provides a gateway to manage the communication between the microcontroller and the Wifi module. It is also capable of relaunching stand-alone applications.

This module is designed with an integrated USB port and a rich assortment of pins. To connect the nodeMCU to the computer and flash it seamlessly, we have need a micro USB cable.

#### C. The different pins

The microcontroller has 16 GPIOs (11 Digital I/O) available on the development board pins. On the 25 pins, we have:

- 4 PWM outputs
- Some pins are reserved for serial communication protocols (SPI, I2C, Serial).

Note also the presence of two push buttons:

- Rst allows you to reset the card (reset)
- Flash allows you to launch a memory flashing sequence, without having to play with the PINs. Useless when using the Arduino IDE.

It also has an analog input called ADC. The conversion is done on 10 bits, so a value from 0 to 1023 and the maximum value corresponds to an input of 1 Volt.

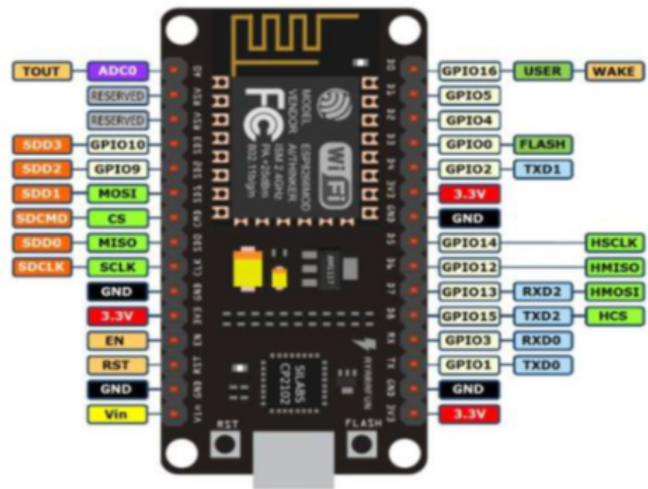


Fig. 2. NodeMCU Pins

TABLE I  
NODEMCU PINS

IO index	ESP8266 pin	IO index	ESP8266 pin
D0 [*]	GPIO16	D7	GPIO13
D1	GPIO5	D8	GPIO15
D2	GPIO4	D9	GPIO3
D3	GPIO0	D10	GPIO1
D4	GPIO0	D11	GPIO9
D5	GPIO14	D12	GPIO10
D6	GPIO12		

#### D. Supply Mode

The NodeMCU can be powered in several ways:

- Via the USB port: this voltage is also exposed via the VU pin.

- Via the various 3 v pins: in this case, the ESP is supplied directly, there is no longer any regulation, which therefore offers minimum consumption.
- By the Vin pin, which supports up to 20 volts and goes directly to the regulator.

#### IV. THE RFID MODULE

##### A. Presentation of the RFID module

RFID or Radio Frequency Identification is a radio frequency card that records and retrieves data remotely [1].

Without physical or visual contact, this technology uniquely identifies the object or person wearing the tag . Invisible frequencies, magnetic fields or radio waves are used.



Fig. 3. RFID module

##### B. The functioning of RFID chips and tags

RFID retrieves data through radio waves [2]. A secure form of data transfer, it also enables P2P communication with NFC-enabled devices. The RFID system consists of an RFID tag (called a tag), an RFID reader and an antenna. During a transfer, the RFID tag is interrogated by the reader, which transmits a signal to the tag through the antenna. The label returns requested information.

##### C. Types of labels (tags)

There are three:

- Passive tags such as access badges only respond to questions and requests from a reader. Passive RFID works in read-only since the chip does not have a battery and must be moved towards the reader to be read. A powerful electromagnetic signal is then sent to it, which activates the RFID chip and reads the information it contains.
- Active tags: they have an energy source integrated into the chip, they are autonomous and do not need the reader's energy to transmit their data.
- BAP (battery assisted passive) tags: record information using sensors.

##### D. Types of media for RFID chips and NFC chips

- RFID cards and RFID badges: personal identification, contactless payment, company access control, loyalty card transport

- RFID contactless PVC label: identification and traceability, efficient and affordable RFID technology.
- Labels and vignettes: identification of goods, keeping stock and making inventories, fight against counterfeiting, transparency for the use of products, promotion at events.
- Bracelets: identification of people, remote payment, promotion taking into account certain events.
- Key fobs and badges: facilitating entry and exit for residents, premises and car parks and the use of the RFID badge for access to businesses.
- Microchips under the skin: identification of animals.

##### E. Reader frequencies and distances

The frequency is the characteristic that establishes communication between the chip and the antenna. All chips on the market have differences in their functionality. Chips have a variation in operating frequencies and also a variation in read distance. The higher the frequency, the greater the read distance. Compared to these parameters, we notice that the chip will be more or less powerful and more expensive depending on its criteria. RFID chips are divided into three types of usage frequencies:

- Low frequency (125Khz): reader distance 0.5m, transfer rate 1kb/s.
- High frequency (13.56 Mhz): reader distance 1m, transfer rate 25kb/s.
- Very high frequency (UHF): reader distance 3 to 6m, transfer rate 28kb/s.

#### V. LANGUAGE AND DEVELOPMENT TOOLS

##### A. The PHP language

PHP: Hypertext Preprocessor which is known by its acronym PHP (self-referential acronym) is a free licensed programming language used mainly for the design of dynamic websites via an http server. PHP, which can be used by any interpretation language locally and for free, is object-oriented.

PHP which facilitated the creation of many websites such as Facebook and Wikipedia is one of the bases for the creation of some dynamic sites and web applications. The PHP language is often associated with the MySQL database server and the Apache server so that it can integrate into HTTP servers such as nginx or IIS. It generates HTML, CSS or XHTML code, data or PDF files. For Linux and Windows operating systems, LAMP and Wamp server are used respectively.

This language, which is free, free, simple to use and easy to install, requires a good understanding of the usual functions and also an acute knowledge of the security problems linked to said language [10].

##### B. HTML and CSS languages

###### 1- HTML:

HTML (HyperText Markup Language) is a markup language derived from the Standard Generalized Markup Language

(SGML, a more general purpose markup language. It allows to create and structure Web pages. Web pages use HTML format. These HTML pages are generated in whole or in part automatically. Otherwise, they are written with a text editor.

If the HTML language makes it possible to display pages of a wide variety of content, formatting, animations and others. It also has the quality of being able to be written with a simple text editor, which avoids the use of a specific application. However, the markup syntax must be respected, even if certain deviations are tolerated. You can write HTML yourself in the case of a static page, or let a script produce HTML on the fly. Simply create a file with the suffix .html and open it in a web browser, giving the file path prefixed with the protocol file:// or double-click or right-click and select open with your web browser.

## 2- CSS:

The term CSS is the English acronym for Cascading Style Sheets which can be translated as "cascading style sheets". CSS is a computer language used on the Internet to format HTML or XML files. But also style sheets are called CSS files that include code. The latter allows you to manage the design of a page in HTML. HTML can be formatted using tags provided for this purpose.

These days it's more preferable to use CSS and only use XHTML for content. The advantage of using a CSS file for formatting a site lies in the possibility of modifying all the titles of the site at once by modifying a single part of the CSS file. Without this CSS file, it would be necessary to modify each title of each page of the site. Other strengths are noticeable. It is possible to create a specific style sheet for printing documents. This makes it possible to remove all style effects and all unnecessary parts during printing. Thus, a style sheet can be used for mobile phone users, which makes it easier to manage formatting for the small screens of these devices.

This book takes up the W3C specifications of which CSS is a part, but by making them intelligible to the uninitiated and by adding advice, examples, tips... It requires knowledge of the basics of the HTML language as a prerequisite. , possibly XHTML for which CSS may become absolutely necessary [12].

## C. WampServer

WampServer est un environnement de développement local ou en ligne pour les applications Web dynamiques. WampServer travaille dans l'environnement Windows en proposant Apache HTTP Server, PHP pour l'interprétation du langage de script, MySQL et aussi phpMyAdmin pour l'administration Web des SGBD MySQL. Il comprend tous les logiciels nécessaires pour exécuter des applications Web PHP sur une machine locale. Il dispose d'une interface d'administration permettant de gérer et d'administrer ses serveurs au travers d'un tray icon. WampServer permet aux développeurs de tester leur

code et d'apporter des modifications sans avoir le télécharger sur un serveur en direct [13].

## D. Sublime Text

Sublime Text is a text editor coded in Python and C++ which presents an original interface as well as numerous functionalities. Among these, you will have syntax highlighting, autocompletion and several search tools. A sidebar, also called a minimap, offers the ability to quickly navigate and preview your source code.

In addition, you will have the means to use macros to automate your tasks and simplify your work. In the same line, the software integrates the automatic backup of your projects. Sublime Text also stands out thanks to the many programming languages compatible with JavaScript, C, C++ , C# , LaTeX, Perl, PHP, Ruby, CSS, SQL, XML and even XLS standards. This text editor displays a sleek and neat interface that is simple and pleasant to use. Finally, note that this software is offered here in a free trial version [14].

## VI. SYSTEM DESIGN AND RESULT

### A. General Architecture

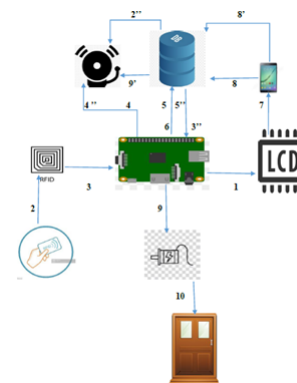


Fig. 4. General Architecture

### Legend :

1: the LCD screen displays Welcome then Scan your badge  
 23. 2: the person presents the RFID card. 3: the RFID module scans the card. 4: verification of the existence of the UID of the scanned card in the database. 5: If the map is saved in the database. 6: The LCD screen displays "Enter your password". 7: The person types the IP address of the MCU (192.168.43.109) on the URL. He accesses the web page which allows him to enter his password. 8: The system checks whether the password entered matches the one stored in the database. 9: If the password is correct the servo motor starts moving and pulls the door hook. 10: The door opens. 8': The password does not match the one in the database. 9': The buzzer triggers an alarm. 2'': the map does not exist at the database level. 3: The LCD screen displays Bad badge. 4'': The alarm sounds.

## B. Detailed explanation

We create a database called arduino containing the following four tables:

- Card; - Passenger; - Door; - Passage.

The following class diagram presents the configuration.

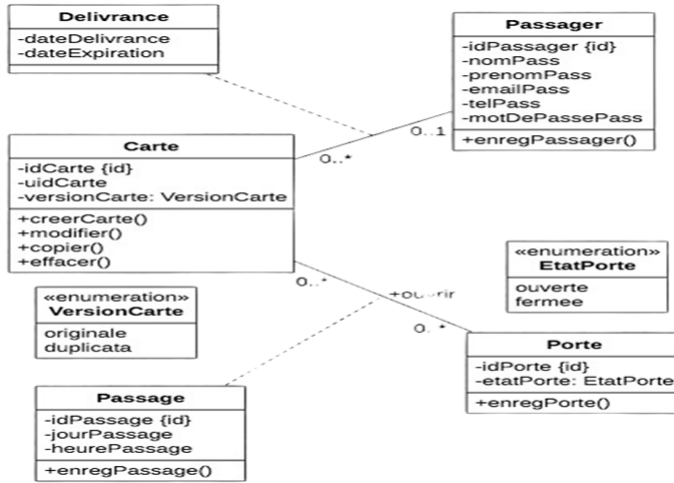


Fig. 5. System class diagram table

On the other hand, in the log table are stored the personal information of all the people who tried to open the door as well as the exact date and time of the attempt as well as the state of the door.

The system works as follows:

- The LCD screen displays a welcome message and asks the person to scan their badge;
- The person presents the card in front of the RFID module;
- The system retrieves the UID of the card then checks its existence in the database;
- If the UID exists in the database, the screen asks the person to enter their password.
- The person connects to the same network as the MCU in order to access the web page to enter their password.
- The system checks if the password entered is the same as that of the card presented.
- If the password is correct, the motor runs and the door opens.
- And the card owner information is directly recorded in the log table as well as the exact time, date and status of the door opening (Door status: open).
- Otherwise the LCD screen displays an error message and the buzzer sounds.
- And card owner information is recorded directly in the log table along with the exact time, date and status of the door opening (Door Status: Closed).
- However if the UID of the card does not exist the LCD screen displays an error message and the buzzer sounds.
- The UID of the card is recorded directly in the log table as well as the time, the date and the exact state of the opening of the door (State of the door: Closed).

## C. Presentation of the webpage

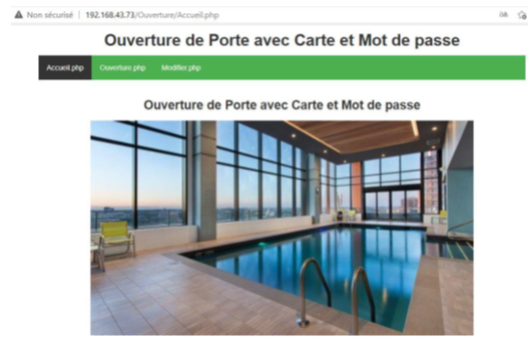


Fig. 6. Home page

- 1) Presentation of the home page;
- 2) Opening page presentation: This page allows the user to enter their password.



Fig. 7. Opening page

- 3) Modify page presentation: It allows a user to modify his password saved at the database level by typing the UID of his card.

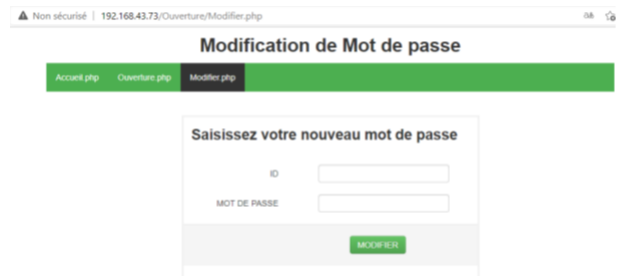


Fig. 8. Edit page

## D. Connecting the various Arduino components with the ESP8266

## VII. CONCLUSION

At the end of our work, we were able to intelligently manage a living or working space through connected objects, including the automatic opening of a door via an RFID card with a password.

First of all, the user presents the badge or the RFID card which is scanned by the RFID module and the system checks the existence of the card at the database level. Then, if the card is well registered then it connects to the network in order to access the web page to enter its password. Otherwise the

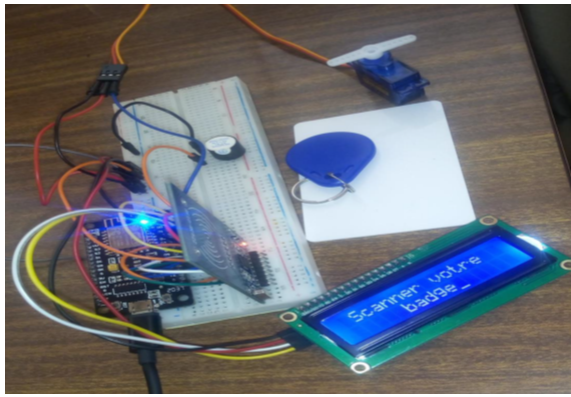


Fig. 9. Connecting the set

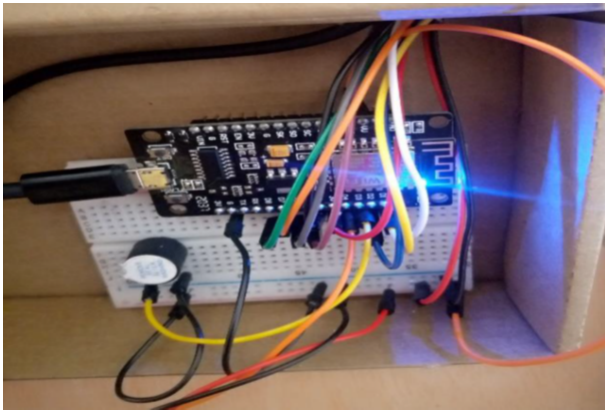


Fig. 10. front of the door

system gives an alert and stops. And finally the door opens if the password is correct. Otherwise an alarm will be triggered. We hope that this project will be the basis for further studies.

#### REFERENCES

[1] R. Colella and L. Catarinucci, "Electromagnetic Design of UHF RFID Tags Enabling a Novel Method to Retrieve Sensor Data," in IEEE Journal of Radio Frequency Identification, vol. 2, no. 1, pp. 23-30, March 2018.

[2] M. Zgaren, S. Mohamad, A. Amira and M. Sawan, "EPC Gen-2 UHF RFID tags with low-power CMOS temperature sensor suitable for gas

applications," 2016 14th IEEE International New Circuits and Systems Conference (NEWCAS), Vancouver, BC, 2016, pp. 1-4.

[3] S. Kaur, R. Singh, N. Khairwal and P. Jain, "Home Automation and Security System", Adv. Comput. Intell. An Int. J., vol. 3, no. 3, pp. 17-23, 2016.

[4] M. Mrinal, L. Priyanka, M. Saniya, K. Poonam and A. B. Gavali, "Smart home - Automation and security system based on sensing mechanism", Proc. 2017 2nd IEEE Int. Conf. Electr. Comput. Commun. Technol. ICECCT 2017, pp. 1-3, 2017.

[5] P. Shelke, S. Kulkarni, S. Yelpale, O. Pawar, R. Singh and K. Deshpande, "A NodeMCU Based Home Automation System", Int. Res. J. Eng. Technol., vol. 9001, pp. 127-129, 2008, [online] Available: www.irjet.net.

[6] Martin, F., Velez, P., Munoz-Enano, J., & Su, L. (2023). RFID Sensors for IoT Applications.

[7] Myint, H., & Tun, M. Z. (2020). Secure Door Control System using RFID Card. International Journal of Advances in Scientific Research and Engineering, 6(04), 69-73.

[8] Hamzah, A. S., & Abdul-Rahaim, L. A. (2022, May). Smart Homes Automation System Using Cloud Computing Based Enhancement Security. In 2022 5th International Conference on Engineering Technology and its Applications (IICETA) (pp. 164-169). IEEE.

[9] Landaluce, H., Arjona, L., Perallos, A., Falcone, F., Angulo, I., & Muralter, F. (2020). A review of IoT sensing applications and challenges using RFID and wireless sensor networks. Sensors, 20(9), 2495.

[10] <https://fr.wikipedia.org/wiki/PHP>

[11] [https://fr.wikipedia.org/wiki/Hypertext\\_Markup\\_Language](https://fr.wikipedia.org/wiki/Hypertext_Markup_Language)

[12] [https://fr.wikibooks.org/wiki/Le\\_langage\\_CSS](https://fr.wikibooks.org/wiki/Le_langage_CSS)

[13] [https://www.01net.com/telecharger/windows/Internet/editeur\\_de\\_site/fiches/28739.html](https://www.01net.com/telecharger/windows/Internet/editeur_de_site/fiches/28739.html)

[14] <https://www.clubic.com/telecharger-fiche430809-sublime-text.html>



Fig. 11. Behind the door