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Proposal access system based on embedded systems running Linux

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***Abstract* — This article is dedicated to the design and implementation of an embedded access system. Describes the design and implementation of the system and what components it is made of. Next, we will learn about RFID technology, how RFID works, where RFID technology and the RFID MFRC522 reader with the ESP8266 board are used everywhere. The second part describes what Linux is, how Linux works, what its versions are and how little about the Armbian. The third part describes how to install the Armbian on Orange Pi Zero.**

***Keywords* — Embedded system, RFID, Tag, Reader, Linux, Armbian, Orange Pi Zero, MFRC522, ESP8266**

I. SYSTEM PROPOSAL

Since embedded systems are currently very widespread and can be met at every step, we have decided to use them to design and implement the access system. Access systems are systems that are used to access rooms, buildings, premises, and so on without using keys. They are very popular and are increasingly replacing the classic key system. Our access system will be comprised of three components. The main part represents Orange Pi Zero, which serves as a Linux web server. The NodeMCU ESP8266 is used to communicate with the MFRC522 RFID Card Reader. The server (Orange Pi Zero) connected via the Ethernet cable to the router will communicate with the NodeMCU ESP8266 via a local WiFi connection and a card reader will be connected to the ESP8266. All this works by attaching a card to a reader to send information to ESP8266. It then evaluates it and sends it over the wifi to the server where it compares the data of the attached card with the data in the server database. He decides whether or not the card has access. If yes the door opens. We can manage all the tabs in the database on the created websites, see, for example, who and when they went or left the building

II. RFID TECHNOLOGY

RFID is an abbreviation of the English term Radio Frequency Identification, radio frequency identification, i.e. identification by electromagnetic waves. The beginnings of this technology go back deep into the second half of the last century. In the context of the ongoing globalization of the economy, pressure has increased on the registration of the transported material, the goods and its storage. Contemporary IT development then provided the tools to effectively address these issues. The first, now universally widespread way of identification has become the barcodes that have begun to promote the American business chain, Wal-Mart. In 1969, American Mario Cardullo came up with the idea of contactless RFID identification via memory chips. Storing information in electronic form in this way should become a direct competitor and a successor of barcodes. The patent was acquired in 1973, and subsequently in the 1970s, a whole range of companies, including e.g. IBM, ComServ or Fairchild, began to take part in the development of this technology. In the 1990s, the first standards created the conditions for the international use of RFID technology. RFID technology has begun to be used not only in business practice for tracking goods and logistics, but also for other purposes, such as proximity chip cards for entry control, passports, ID cards, or, for example, sports not only for users of ski lifts but also

for various racers to measure time by the sensor. At present, RFID technology does not aim to replace barcodes, but rather to supplement them with other options. In a number of applications, it is advantageous to use a combination of these two technologies. [1].

A. How does The RFID work?

The basic principle of RFID technology is relatively simple. The system consists of three parts, such as the antenna, the receiver / transmitter (reader) and the information carrier, i.e. the tag. RFID belongs to a group of technologies for automatic identification and data collection - AIDC. AIDC methods can automatically identify objects, collect data, and put these data directly into computational systems with minimal or even no human intervention. Information is sent and retrieved from RFID tags using a radio wav reader. For passive systems that are most widespread, the RFID reader will create an electromagnetic field that will "wake up" the tag and provide its energy for response through the so-Backscatter. For active systems, the battery is placed in the tag used to increase the effective range of the tag and support other features that passive tags do not have, such as sensing physical quantities such as temperature, pressure, humidity, and so on. (These tags are referred to as Transponder and Data loggers). The data collected from the tags are sent from the reader via the communication interface to the host computer system in the same way as the data obtained by scanning the barcodes. RFID is similar to barcode technology, but it uses radio waves to capture, tag data instead of optical barcode scanning from the label. RFID does not require direct reading when reading the stored data - this is one of the key features of the RFID system. Another feature that barcodes will never allow is an option not only to read the tag, but also write and rewrite it. [2]

B. Where is The RFID Technology used?

Most people do not even know how many times a day they use RFID technology. Access cards, building keys, automated toll collection on motorways, trucking stations, kiosks are all around us and use RFID technology. Hotels now use RFID for key room equipment, hospitals use it to check inventory, asset management depots and building sites for tracking tools, options are almost endless. While most of these applications have been around for several years, others are developing every day. Whether it's brands of bracelets at popular music festivals, golf balls at driving ranges, interactive toy toys. RFID technology is growing rapidly and Internet applications are being brought to life every day. [3]

III. RFID READER MFRC522

The RFID reader with the built-in antenna contains everything you need for easy use. RFID devices can take different forms than cards, stickers, bracelets or circular pendants, and are also divided according to the frequencies used. This module contains the MFRC522 control circuit and operates at a frequency of 13,56 MHz. We'll show you how to link the ESP8266 board reader and how to load the addresses of the different tags and use them in the program. This reader is shown in Fig. 1.

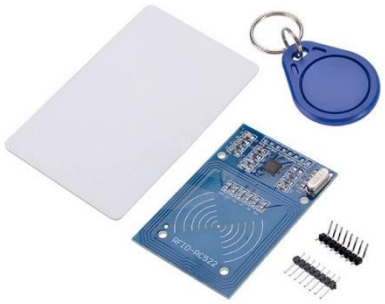

Fig. 1 RFID Reader MFRC522

You need to connect a total of 7 wires to the MFRC522 reader with the ESP8266 board. We connect SDA to pin D8, pin SCK to pin D5, pin MOSI to pin D7, pin MISO to pin D6, GND to GND, RST to

pin D1 and 3.3V to pin 3V3 to ESP8266. The reader module communicates with ESP8266 using the SPI protocol and therefore it is necessary to use these selected pins on the ESP8266 board. Only SDA and RST pins can be changed, and changes need to be made at the start of the program. The resulting connection can be seen in Fig. 2.

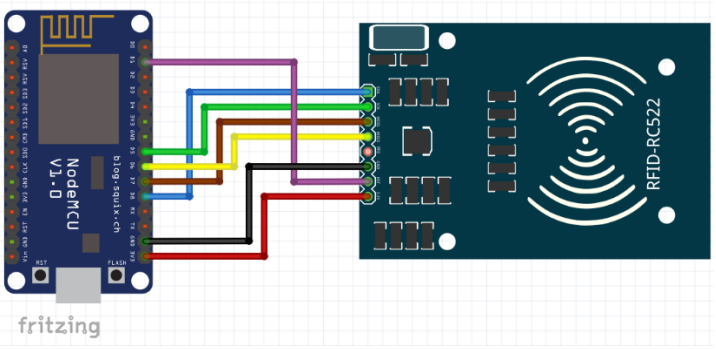

Fig. 2 Connecting ESP8266 and MFRC522

An RFID reader with integrated antenna is a simple module that can be used, for example, for various security devices when we want to create our own access, attendance system or perform certain activities for individual tags. [4]

IV. LINUX

Linux is a free, open source operating system running on the Linux kernel. It was created in 1991 by Linus Torvalds and his students at the University of Helsinki, Finland. Torvalds built Linux as a free and open source alternative to Minix, the next Unix clone that was mostly used in the academic environment. He originally intended to be called "Freax," but eventually decided to combine his baptized Linus and Unix words. And so a new operating system called Linux was created. [5]

A. How does Linux work?

Users can use free to edit and create variations of source code, known as distributions, for computers and other devices. In this way they have access to all source codes, they can integrate new features or quickly find and remove program errors. Linux is in many ways similar to the operating systems we use, such as Microsoft Windows, OS X or iOS. It has a graphical interface and software types that we are used to on other operating systems, such as word processing applications or web browsers. Not everyone uses Linux because it's a little more difficult to manage than Microsoft Windows. However, if we can use it, there are several configuration options than Window and offers more flexibility in use. The Linux kernel distinguishes the Linux operating system from other systems. This kernel is located in the central part of the operating system and controls the security of the operating system, the hardware interface and serves as the primary source for the operating system itself. The kernel contains source code that is available to everyone, allowing you to customize your operating system to suit your individual needs. Many companies and organizations use the core to design operating systems that are tailored to the needs and requirements of the company. Linux is referred to as a server platform because it has the ability to create the basis on which the operating system can be created and which can be used as an alternative to the Microsoft Windows operating system. Thanks to its ability to work as a platform, it can also be used as a microchip for other devices and devices. [5], [6]

B. Where is Linux used?

Currently, Linux uses millions of users around the world. You probably also use Linux, whether you know it or not. Users' composition differs from private users, training companies, universities, and businesses or research centers. For example, businesses and individuals choose Linux for their servers because they are safe and can receive excellent support from a large community of users, such as Canonical, SUSE and Red Hat, offering commercial support. Many devices we own, such as Android phones, digital storage devices, personal video recorders, cameras, carriers, and more, also use Linux. Even our car has Linux running under the hood. [5]

C. Versions of Linux

Linux has many different versions that suit almost any type of user. These versions are called distributions. Almost every Linux distribution can be downloaded for free, burned to disk or USB and installed on as many computers as we want. There are two major distributions of Linux. So-called desktop devices that have a graphical interface (GUI) installed. Essentially, these are full-featured operating systems such as Microsoft Windows and are especially suited to less experienced users. And then they are Linux servers that do not have a graphical interface and need to know how to use them at the command line. The most used desktop distributions for Linux:

- Ubuntu Linux
- Linux Mint
- Arch Linux
- Fedora
- Debian
- openSUSE

The most used server distributions for Linux:

- Red Hat Enterprise Linux
- Ubuntu Server
- CentOS
- SUSE Enterprise Linux [7]

V. ARMBIAN

The Armbian is basically a lightweight Linux distribution of Debian or Ubuntu dedicated to ARM development boards. It has powerful software development tools, long-term end-user support, security and fast fixes. Here are some supported boards: Beelink X2, Orange Pi Plus 2, Orange Pi Plus 2E, Orange Pi Lite, Roseapple Pi, NanoPi M1, NanoPi M1 +, NanoPi Neo, NanoPi Neo2, NanoPi Duo, Le Potato, Espressobin, Pinebook A64, pcDuino2, pcDuino3, Odroid C0 / C1 / C1 +, Banana Pi M2 +, Hummingboard 2, Odroid C2, Orange Pi 2, Orange Pi One, Orange Pi PC, Orange Pi PC2, Orange Pi Zero. [8]

A. Orange PI ZERO – Installation of Armbian

So we will need hardware and software to install Armban. As for the hardware, of course, we do not need to do without Orange Pi Zero, the 5V / 1A best 2A with a MicroUSB connector, we will use a classic phone charger that you can usually get in any e-shop, micro SD card class 10 or better, we use 16GB MicroSDHC from Kingston and finally Ethernet cable and card reader. You should also be careful not to buy network adapters from China, which praise 2A but give only 0,3A. That would not work very well. And beware of poor memory cards. From the software page, we need the Linux itself, we will use Armbian Xenial, which can be downloaded from www.armbian.com, a program for writing Linux to the Win32DiskImager SD card and a Telnet client such as Putty. [9], [10]

We are going to do it. We download the Armbian archive and unpack it. We install Win32DiskImager and Putty. Then insert the SD card into the reader and reformat it to make sure the card is out of the question. Simple, fast formatting of the basic settings is sufficient. Run Win32DiskImager, find the Linux file on the *.img hard drive, and on the right, choose the drive letter we want to write. Click Write and wait about 2 minutes, depending on the card speed before the file is written to the card. This is illustrated in Fig. 3.

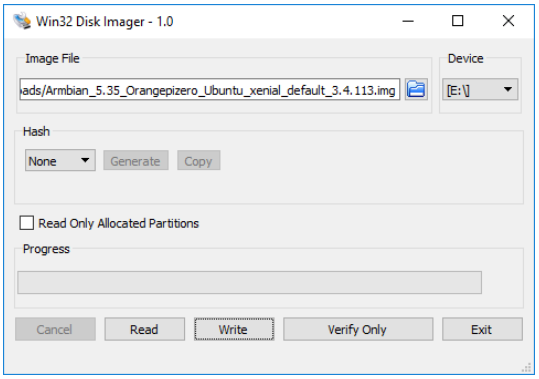

Fig. 3 Write a file to the SD Card

After successful registration, we will pull out the card, insert it into Orange Pi Zero, connect it to the Ethernet cable to our home network (to wifi router) and connect to the 5V source. The D7 green LED lights up a minute and the red D8 LED flashes in another 1 to 2 minutes. At this point we have to find out what IP address our Orange Pi has obtained from the home router's DHCP server. We look into the router's web interface where we get an IP address. In our case, it's 192.168.1.105. Run Putty and type in the Host Name line with our IP address and just enter Enter, Fig. 4.

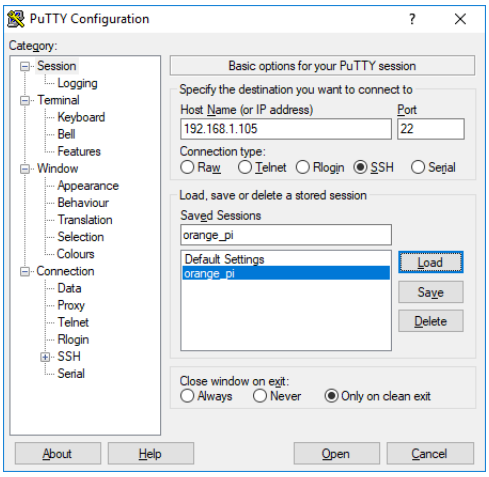

Fig. 4 Putty program setup

A security alert will pop up if we trust this server and we click Yes. The login screen will appear, where you enter the root in the logins and press Enter, Fig. 5.

Fig. 5 Putty program setup

On the next line for password, type 1234 and press Enter again. Within a few seconds, the Armbian

startup screen will appear, where we will learn that a system reboot is needed (a SWAP partition is created and a 1,2 GB partition is added to the entire card). [11] But first you need to change your password by typing the current UNIX password 1234, simply enter Enter, enter new UNIX password, press Enter, retype new UNIX password, enter again and is done. This is shown in Fig. 6.

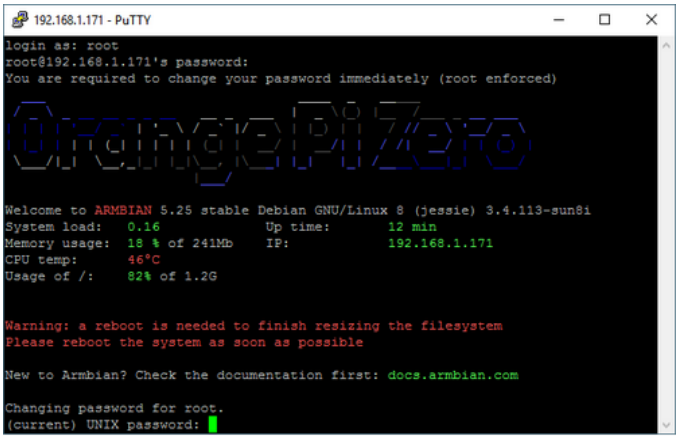

Fig. 6 Password change after login

We are also asked if we want to create a new user account. For example, we write the login name for Miroslav to enter the password twice and we have created the new user, picture Fig.7.

The startup setting is complete and the command line suddenly appears miroslav@ orangepizero: ~ # we type reboot and press Enter. Putty disconnects and we can turn it off. Orange Pi is now restarted and changes in partition size on the memory card are made. It takes a while, so wait for about two minutes and try to connect via Putty again using our username and password. After logging in, the installation is complete. [12], [13]

VI. CONCLUSION

In this article, we were able to read about the design of the access system, the implementation or components of which are composed. We also learned something about RFID technology as RFID technology is how it works and where it is used everywhere. The next part describes the Linux operating system, how it works, what are its versions, and we have described one of the Linux distributions, Armbian. We finally installed this distribution with Orange Pi Zero.

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