DIGITALIZATION OF MARKETING
THROUGH LED PANELS USING Wi-Fi TECHNOLOGY

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Abstract: *This project has the main objective to study some main functions of hardware and software of panels with LED diodes using Wireless technology communication to communicate from computer to the LED diodes panels. It is also focused on the programming of LED matrix diodes located on 16X96 electronic panels, respectively 16 rows of 96 columns. Also, there is elaborated the study of the mode of operation, composition, coding and use of software for panel diodes using the wireless technology to change the panel program each time it is needed. In the focus of all this is the introduction of diode panels in use at „Kadri Zeka" University exactly at the Faculty of Computer Science to provide digital information to students, professors or anyone passing through the premises of the university that is happening inside the classrooms of the Faculty of Computer Science. This happens in real time in accordance with the schedule of lectures and exercises in the respective classrooms of the FCS. In fact, this project explains in detail the concept of LED diodes and microcontrollers, their features, operation, power supply and work with 0 [VDC] and 5 [VDC] voltages, respectively 0 and 1 logic bits. Meanwhile, the project also explains how coding, how the software is developed to switch on, and switch off LED diodes on a 96X16 LED diode panel, thereby producing text on the panel (display, screen) in static, mobile, animation or up-down, left and right movements according to the time allocated to the timers of the microcontrollers. Such actions achieve the goal of the digitalization project of the classrooms of the Faculty of Computer Science. The same technology and all the hardware devices are possible to be used in all the marketing to represent information about different scopes.*

Keywords: *LED diodes, Wi-Fi, light-emitting diode panels, digitalization, microcontrollers, memory, microprocessors, source codes, software, text.*

1. INTRODUCTION

1.1. Usability of Wi-Fi technology

Wi-Fi can be used in many locations where it is harder to communicate using wires, such as: schools, universities, campus, hospital, airport, bus station, train station, hotels, restaurants, library, and many other locations in order to communicate in intranet and internet as well. Hotspots (network distributed devices) can be placed on one or more than one place in order to cover the area with the network [13].

In this case, usage of the Wi-Fi technology on the LED diodes panel are placed on the higher areas where it cannot be reached by people without any other helpful stair and are used for marketing, presenting any timetable, student scheduling, temperature or other information, can be attractive and nice looking.

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This study has to deal on putting the LED diodes panels of size 96x16 monochrome with green light which panels that has integrated wireless device inside in order to work as access points, on the entrance doors of the study rooms at Faculty of Computer Science in University "Kadri Zeka" in Gjilan - Kosovo, in order to give information to students, professors, or any other who is walking around the rooms to learn what is happening in each individual study room or other university room. Of course, to give such information we are using the LED diodes panel and switching on or off the diodes to draw the certain letters and to form the words.

2. CHARACTERISTICS OF LED MATRIX PANEL

The panel that is the object of study and review is not the most qualitative in the market, but performs the function for which it is explored, and any other model works according to the same principles.

Figure 1: Led Panel 96X16 diodes and information about what
is currently happening in the room B24 FSHK's

Table 1: Characteristics of LED panel 96 X 16 diodes [7]

Model	HD – E65
Chip type	Supports only green color
Distance between LEDs	10 [mm]
Supply voltage and electricity	5 [V] 40 [A]
Luminance	≥ 7500 cd/m² (for outdoor)
Light module format	32 X 16 LED
LED number for module	512 LED
Panel Dimensions	110 x 10 x 22 [cm]
The amount of power consumption	20 [W] – 40 [W]
Number of modules	3
Angle of view	120° horizontal, 60° vertical
Working temperature	-20 [°C] ~ +60 [°C]
Supply to the city's electrical network	Alternative electricity 100 ~ 240 [VAC]
LED diodes for panel	96 X 16 LED
Total number of LEDs on the panel	1536 LED

Figure 2: Moving text, digital day and time

2.1. ML 96 x 16 R (model: HD E-65)

The digital display is able to emit static text, moving, displacement, animation, cyclic, scroll, slug, blinker, that text moves from left to right, from right to left, bottom-up, top-down or similar movements. Shows the correct time, date, temperature and even one or more rows depending on the number of diodes according to the lines of the display (relatively with high resolution). 24 types of animations can be selected for text you can adjust the speed of the text movement [7]. The possibility of the timer display option that automatically activates or deactivates the device programs within certain time intervals. In the computer is formed a text, the module is programmed and it can be stored and then transferred to USB connected to the appropriate port of the diode panel and transferred as text on the display. The text on the digital display is easily programmed through software that works in the Windows operating system. The system recognizes and can perform with different types of fonts that are used on the Windows operating system [7]. The LED panel programming is performed through the respective software installed on the personal computer and transferring the program through USB port with USB memory, via RF or Wi-Fi technologies!

Figure 3: Two panels connected physically and present the inscription of the University
Digit: ML96X16R; HD2016 LED Display Controller; Card Model: HD E-65

2.2. Illuminating Diode (LED)

LED is the abbreviation of English words „light-emitting diode", that is, a light-emitting diode. The illuminating diode is built in the same way as the usual semiconductor diode. It will work if it is polarized on the right side [1], [2]. The intensity of the light is regulated by the current which flows through the diode also exponentially. The diode will not emit light when it is polarized in the opposite direction. The color of the light emitted depends on the type of semiconductor and the added impurities. The diode produced by gallium phosphate (GaP) emits red light while that of gallium arsenide phosphide can emit light green or yellow [1], [2]. The graphic symbol and characteristics of the light-emitting diode are shown in Figure 4 as follows:
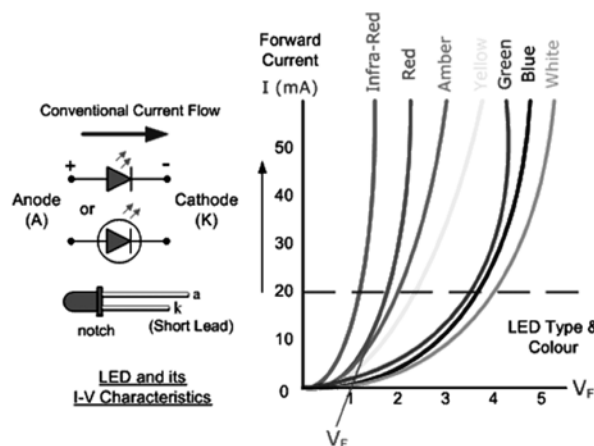

Figure 4: Characteristics of LED diodes [5]

The advantages of light-emitting diodes are small size, safety at work, long term service, work with low tensions and currents, small losses of electricity, great work speed.

2.3. Usability

LED Light-emitting diode are used for signaling, through which the open or closed status of an electronic circuit is indicated. Especially they are implemented in bright light indicators. *LED diodes*. At the moment of power supply of LED diodes with semiconductor material content is of gallium arsenide phosphide and its positive polarization leads to electron bulging causing the production of light waves in the range of 550 to 640 [nm] [4], [5]. Breaking light on the conic lenses of the observer's eye (human) creates a sense of perception of the green color according to the spectrum of the colors of the light waves [4], [5]. In other cases, semiconductor material and semiconductor diodes will produce light beams at other intervals of the wavelength and creates a sense of perception of the respective color, always according to electromagnetic spectrum ranges of electromagnetic wavelengths as shown in Figure 5.
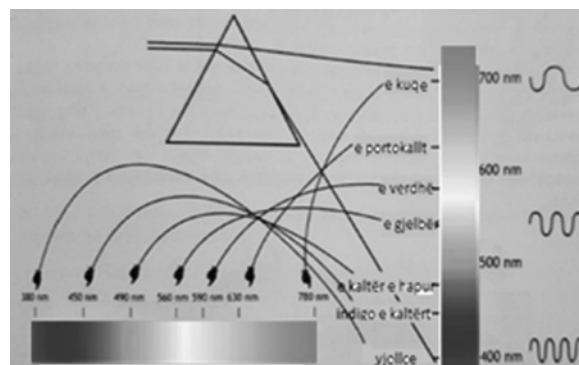

Figure 5: RGB base color spectrum acquired by the length range
of the light beam (electromagnetic wave) [5]

2.4. LIGHTNING DIODE (LED)

LEDs are special diodes that emit light when connected to an electrical circuit. They are often used as a pilot lamp in electronic applications to show when the circuit is running or not. In a right polarized diode, free electrons pass the union of p-n contact and become conductive. If these electrons pass from a higher energy level to a lower power level, they generate energy. In ordinary diodes like Silicium (Si) or Ge (Germanium), most of this energy goes in the form of warmth. In other materials such as gallium (Ga), Arsenic (As) and Phosphorus (P) or Gallium-Phosphorus (GaP), the number of photons of light is sufficient to create a visible light source [1]. In light emitting diodes, this energy radiates as light. The most important part of an LED is a semiconductor chip placed in the center of the lamp. The chip has two layers: the **p** layer has mainly positive electrical loads and the layer **n** with negative electrical loads. When a sufficient voltage is applied to the diode, the electrons can flow easily in one direction to the **p** and **n** layer contacts. So, it starts to flow the current, because layer electrons **n** has enough energy to move to the **p** layer [1]. When an electron moves and falls on a positive load, both loads are recombined, so when an electron hits a hole, it falls to a lower level of energy and emits energy in the form of a photon. Whenever an electron is recombined with a positive load, the potential electric energy is transformed into electromagnetic energy [1].
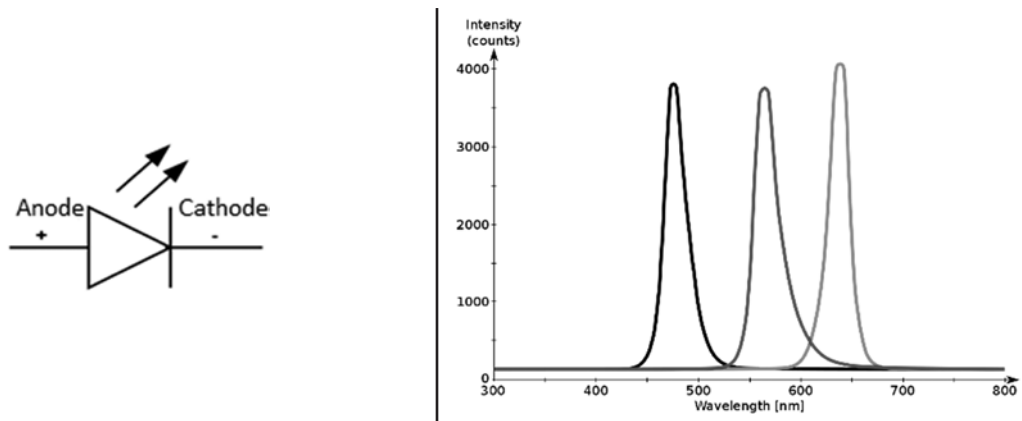
Figure 6: Graphic symbol of LED light-emitting diodes [6]

Some of the LED uses in everyday life are:
- architectural lighting,
- indicators (condition indicators) in many electronic devices,
- traffic signals and road signs,
- handheld flashlight,
- remote controls thanks to the infrared LED,
- optical fiber for traffic,
- for Christmas tree lights,
- LED anti-acne phototherapy has been effective in the disappearance of acne for a 3-month period,
- lighting panels and other textual descriptions.

2.5. Disadvantages of LED usage

LEDs are more expensive currently than other lighting technologies. LED performance generally depends on the ambient temperature in which it works. By operating the LED at high ambient temperatures, this may result in overheating of the diode and lead to damage (drilling effect) and to malfunction.

2.6. Microcontrollers

The microcontroller contains microprocessor, memory and a large number of peripheral devices such as timers (timer relays), serial ports, input / output pin terminals, numerators, analog inputs and so on. All of these are within a silicon circuit in the form of a built-in system. Examples of built-in systems are: calculators, computers, and smart phones. The microcontroller system architecture has changed from time to time, but what is left behind is the programming language C [3].

The programming language consists of alphanumeric characters, syntax of commands, functions which constitute a program code comprehensible to man, respectively the programmer. On the other hand, the execution of the programming code on the computer is performed when the program code is compiled in the machine language. This implies that each alphanumeric sign of the programming code is converted to the binary code (0 and 1 logic) according to the international agreement the ASCII table or the extended EBDCIC table. This, in effect, represents the string of square time voltages of the lowest level 0 [VDC] and highest 5 [VDC] respectively.

Meanwhile, 5 [VDC] voltage supplies LED light-emitting diodes, which causes LED diode brightness, while 0 [VDC] voltage fails to arouse the illumination of LED diodes [3].

All input data are placed in the microcontroller memory. From the microcontroller memory, the input data is processed in the microprocessor for processing and the results obtained according to the respective software or programming code are stored in the memory and transmitted to the respective ports of peripheral devices and in this case the 96 x 16 diode panel where diodes are placed within an electronic plate. If the microcontroller memory inserts the letter B and the voltmeter (voltage measuring instrument) it will be possible to measure the voltages of each bit in turn we will show the voltage measurements as in the following figure 7:

0 [v], 5 [v], 0 [v], 0 [v], 0 [v], 0 [v], 5 [v], 0 [v], which in fact represents binary number:

0 1 0 0 0 0 1 0 .

Figure 7: Chart tensions 0 [VDC] 5 [VDC], presentation by binary numbers 1 and 0 logic

Presentation of binary digit 1 with voltage of 5 [VDC] or any other value depends on the technical characteristics and electronic components of the microcontroller system. 8-bit array: belongs to the decade number because: viewed at the ASCII - code table, this belongs to letter B.

3.   ARCHIVING OF DATA IN MEMORY

The data in the memory is placed in the form of a byte sequence. Each byte possesses its unique address and can be addressed as in Table 2. Data in the memory can be recorded and read.

Bit positions in a memory address from 0 to 7 of a byte:

Table 2: Presentation of data storage (bytes) in memory

	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Address 0	1	0	1	0	1	0	1	0
Address 1	0	0	1	1	0	1	0	1
Address 2	1	1	1	1	1	0	1	1
Address 3	1	0	0	0	0	1	0	0
Address ...	...	...	...	...	...	...	...	...
Address n	...	...	...	...	...	...	...	...

1 Byte of data   Each cell can store bit of value 0 or 1

3.1. Switching on and switching off the LED light-emitting diodes in the electronic board

When the built-in microcontroller system is connected, all of its pins are initially defined as inputs. To switch on or off LED light-emitting diodes placed on an electronic board, we need to set or describe the values in the respective data entry port (DDR - Data Migration Data Logger). Therefore, for access to Port A, the DDRA register is used, Port B is used for DDRB and so on, where LED diodes are connected [3].

In the pin with index number 5 (PB5) of the plate (Arduino Uno) is connected the LED Illumination. If the bit with position 5 of DDRB is described or transmitted logical energy level or be 1 then port B ordinal number 5 (PB5) is set as PIN DOWN.

The hexadecimal number to be described in this case in the register is: (20) 16 or 0X20, in which case the LED will be illuminated. Therefore, if logic or beam 1 is described in the register, this is the fact that the LED diode is supplied with a voltage of 5 [VDC] which will switch off its illumination.

The binary number in the register $(00100000)_2$ is converted to the hexadecimal as follows:

$$(00100000)_2 = (0010\ 0000)_2$$

$$(0010)_2 = 0 \cdot 2^0 + 1 \cdot 2^1 + 0 \cdot 2^2 + 0 \cdot 2^3 = 2$$

$$(0000)_2 = 0 \cdot 2^0 + 0 \cdot 2^1 + 0 \cdot 2^{2+} 0 \cdot 2^3 = 0$$

Therefore, the hexadecimal number is: $(20)_{16}$! This happens with the best intention that data in programming language C are written in hexadecimal format rather than binary format. The programming code example C in the programming language C for diode input is defined as follows:

```c
int main(void)
{
    DDRB = 0x20;  // set bit 5 of DDR register which makes PB5 an output
    while(1)
    {
        PORTB = 0x20;     // swich LED on
        Delay();
        PORTB = 0x0; // swich LED off
        Delay();
    }
}
void Delay(void)
{
volatile unsigned long count = 100000;
while (count--);
}
```

The result of this programming code in the programming language C is that in the electronic board where LED diode is connected, the same to switch it on or off the LED diode to pulsate by switching on and off at a high frequency.

The file: io.h located at the beginning of the program code enables the registry to be accessible for access. Setting logic 1 to the set bit position in the DDRB registry creates the corresponding pin declaration option as OUTPUT PIN on the PORTB port.

In the loop while (1) the PORTB register is set to enable the LED diode to light up, provided that the corresponding bit in the log has the logical value 1, the same bit is again set but in logical value 0 in order to switch off the LED diode light. Calling the Delay() function between the LED diode switch on ensures that the LED diode remains in the turned on state and turned off enough at a high frequency so that it is visible to the human eye, creating the impression of the constant illumination.

With the while (count) command is reached that the program cycle is repeated whenever the counter count = 100000 decreases for one to the 0 value when also the command while (count--) gets the false value. This actually determines the timing of the LED dialing switch disconnection. At the end of this time according to volatile unsigned long count counter (100000) the program comes out of the cycle and completes its work.

3.2. Array

Programming language C uses successive memory locations that archive specific type of data. For example, the programming string C, consisting of 5 integers, is defined as follows:

> int arr_num[5]; or   unsigned char seq[ ];

Through the definition of the arrays, it is easy to switch on and off LED light diodes placed on an electronic board (LED DIODE PANEL). The following programming code initiates the array through a set of numbers that are described on the LED for their switch on and off [3]. Such array is known as a reference table.

Connecting four LED diodes to the pin terminals of PC0, PC1, PC2 and PC3 microcontrollers is explained in the same way as before. The values in the full-range string are the values that are described (placed) on the microcontroller output port for LED light-disconnection and disconnection. The array of the given numbers is 1, 2, 4, 8, 6, 9, 15, 5, 10, 5, 10. One-dimensional array numbers should be converted to hexadecimal format so that they are read in the file. The programming code for this case of four LED diodes is defined as follows:

```
#define F_CPU 16000000UL
#include <avr/io.h>
#include <util/delay.h>
int main(void)
{
      unsigned char seq[ ] = {0x01, 0x02, 0x04, 0x08, 0x06,
                    0x09, 0x0F, 0x05, 0x0A, 0x05, 0x0A};
      int ind;
      DDRC = 0x0F;         //  lower 4 bits of port C are outputs
      while(1)  {
            for (ind = 0; ind < sizeof(seq); ind++) {
PORTC = seq[ind];
_delay_ms(1000);
            }
      }
}
```

The result of this program code looks like in Figure 8.

Hexadecimal Number	LED diodes of panel Position of LED diodes from 0 to 3 Pin PC0 Pin PC1 Pin PC2 Pin PC3			
	2^3	2^2	2^1	2^0
0x01	○	○	○	●
0x02	○	○	●	○
0x04	○	●	○	○
0x08	●	○	○	○
0x06	○	●	●	○
0x09	●	○	○	●
0x0F	●	●	●	●
0x05	○	●	○	●
0x0A	●	○	●	○
0x05	○	●	○	●
0x0A	●	○	●	○

● LED locked diode; ○ LED unlocked diode;

Figure 8: LED diode connection according to matrix programming code [3]

4. THE HD-E65 LED PANEL SOFTWARE, CONSISTING OF 96 LED DIODE ARRAYS AND 16 ROWS ALSO LED DIODES (96X16) KNOWN AS: HD2016
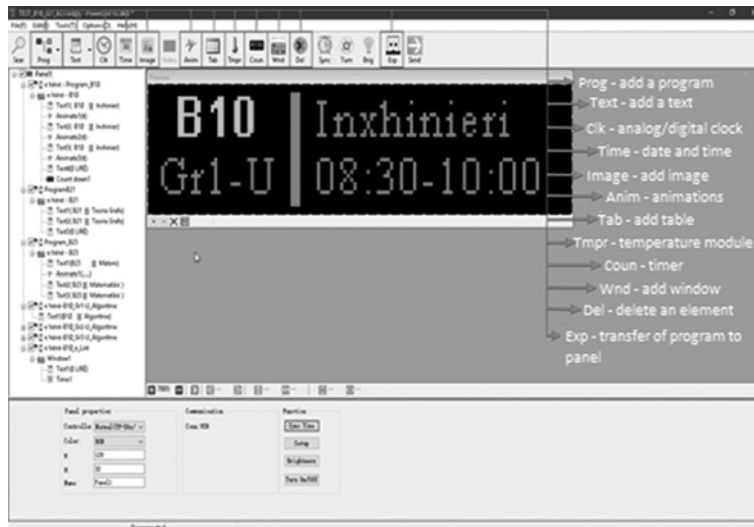
Figure 9: The look of the PowerLed 96X16 Test software

PowerLed is a software used for programming RGB matrix panels, it contains a collection of tools that can be used to program different panels, which consist of menu bar, toolbar, window class, virtual panel windows, feature windows, etc. [7].

For the programming of the LED panel, in special cases the Software is used which is dedicated to 160X32 panels (160 columns with diodes and 32 rows) model [7]: HD2016, Module HD – E65, Screen Size: 160X32, Color: Single color, Communication: Com port, U disc, Ethernet, Memory: 2M.

Therefore, for panel programming, we need to consider which software is available for use.

When programming a LED panel with a 96X16 LED diode via a software module for 160X32 LED diode panels, it is necessary to determine the start of the software co-ordinate system so that we can set the text at the top of the panel from left to right. Otherwise, we will not be able to see the desired text because the placement of the text will remain defined outside the positive (real) coordinates of the coordinate system (x,y) . For this case, if the software is designed for 160 columns of 32 rows, then in the extension of the x-axis, move right to: 160 - 96 = 64 positions, which will be considered the point (0.0) for the 96-column panel and 16 rows. Of course, this is achieved by selecting the menus as follows: screen1 / program1 / text1 and window displacement for 64 points in the positive direction of the x axis, while in the direction of y axis only half of the field is transmitted because: 32: 2 = 16.
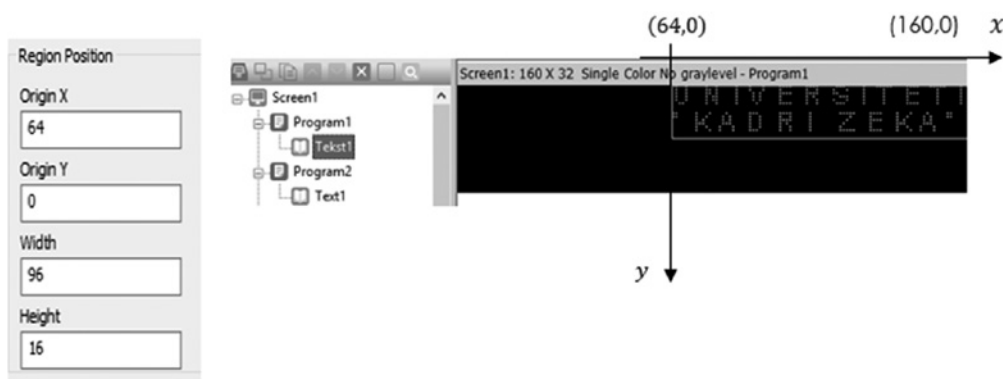

Figure 10: Allocation coordinates of LED panel diode 96X16 160X32 through software diodes

4.1. U disk tool

It is used for exporting screen prepared with certain programs and texts in memory (USB) provided that the Memory Flush is placed in the relevant computer port. After export to Memory Card (USB), the same goes out of the computer port and is placed on the LED panel port. In this case the program is read and the OK message is displayed on the LED panel. At this moment, the flash memory is removed from the LED panel and the device works according to the program now installed on the 96X16 LED panel.
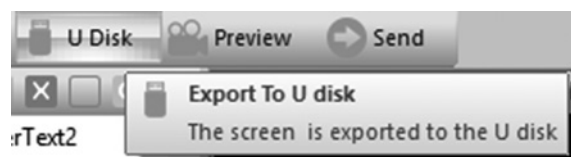

Figure 11: U disc tool

4.2. Program export tools and communication using Wi-Fi

As we have explained previously the LED panel devices could communicate with computers using Wi-Fi built-in devices. The LED panel is used as access point for which the computer who has wireless adapter card can search for the wireless access points panel. On the menu of the application - it is a menu Settings, then you click submenu Communication Settings in order to open the wirelesses of each LED panel. It should connect to the panel wireless SSID and then send the program, as it is shown in the following figure:
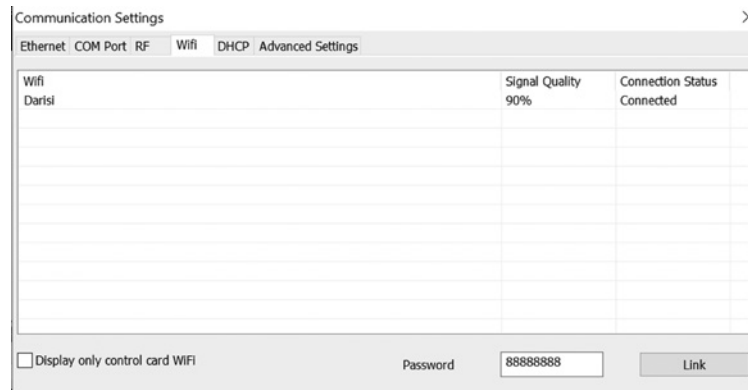
Figure 12: Searching for Wi-Fi signals of panels

On the up menu there are the possible communication ways, one of which is Wifi, if you click it you can see the list of wireless access points of LED panels, then you choose which panel you want to send program code, for example you can see there is one with name Daris that shows Signal Quality.

On the other menu Hardware Settings, we can choose the device and Commonly smart and send the code, see the following figure:
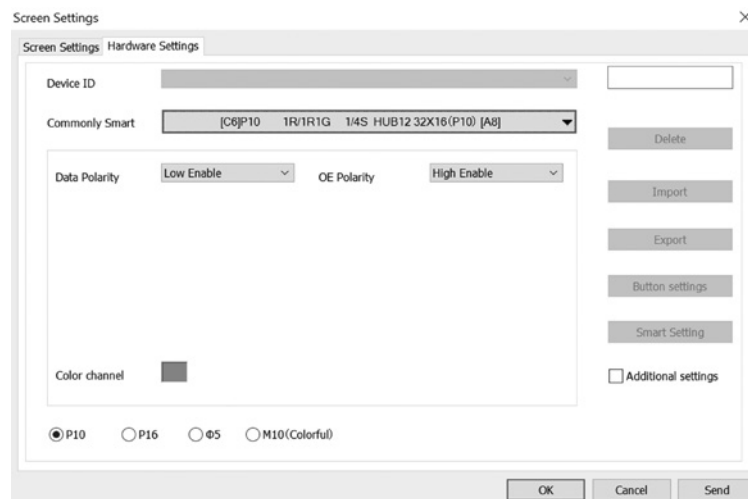

Figure 13: Hardware information and code sending

5. CONCLUSIONS

There are many applications and device who do use wireless technology. In our project this feature of panels who do have wireless card inside it was very helpful on communicating with the LED panels in our University campus. It was very difficult to send the changes on the code to each panel of each study room in our University, because also there are the panels so high put that couldn't be reached easily to send the code by USB. Thanks to wireless card each panel is working as access points, where the computer can easily connect to each panel and send the code.

This was very helpful with wireless technology, but as future work we do propose that there could be done also communication using RFID.

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