

POSSIBILITIES OF CONTROL USING WIRELESS COMMUNICATION AND MOBILE PHONE

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ABSTRACT:

Possibilities and methods for control using wireless communication and mobile phone are considered and described in the paper. Wireless communication technologies and mobile phone platforms that are used in the control applications are described. One practically designed and implemented system for control of home lighting using Wi-Fi wireless communication, Arduino development platform and Android based mobile phone is described. Main characteristics and advantages of the practical implementation are presented.

1. INTRODUCTION

After first computers had appeared, along with data processing on the first business computers, it was started thinking about developing communication between computers and data exchange between computers without external media and using direct connection. The constant growth of computer and communication technologies developed different types of communication and computer networks [1]. Also, it developed and introduced many new communication devices and systems. Very much used and applied are wireless communications and mobile phones. Such systems can also be used in many control applications.

This paper describes possibilities and methods for control using wireless communication and mobile phone. One practically designed and implemented system for control of home lighting using Wi-Fi wireless communication, Arduino platform and Android based mobile phone is described.

2. ANDROID OPERATING SYSTEM

Android is operating system for mobile devices based on the modified version of Linux OS [2]. It is open operating system and free of cost. Most of the Android code has Apache licence which refers to open code. This means that anyone can use Android by downloading its source code. Also, hardware manufacturers can add their own extension and modify Android in respect to their products so they

would differentiate from other products. This simple strategy attracted many manufacturers of mobile devices. It was very significant for companies in the smartphone industry. Some of the manufacturers wanted to find a way to revitalize their own products, and as a result, they all turned to Android [2]. One of major advantages of Android is unified access for application development. Programmers can create applications for everything using Android platform and their applications have the possibility of execution on a vast number of different devices that run Android operating system. Because of this, Android platform was the best solution to many device manufacturers and mobile smartphones users. Because Android has an open code and it is free to all manufacturers and users, there are not precisely defined hardware or software configurations.

3. ARDUINO DEVELOPMENT PLATFORM

Arduino board is a physical computing platform (development system or development platform) of open code type [3]. Hardware is consisted of simple open Arduino board design with Atmel AVR processor (microcontroller) and accompanying input-output elements. Software is consisted of a development environment that has a standard compiler and boot loader on the very plate. Arduino hardware is programmed using a programming language based on Wiring language (syntax and libraries). It is basically similar to C++ language with some simplified changes.

Arduino board has 8 bit Atmel AVR microcontroller and appropriate components that enable programming and interconnection with other devices and systems. Arduino boards use megaAVR series of microcontrollers, ATmega8, ATmega168, ATmega328, ATmega1280 and ATmega2560. The most of boards have 5V linear voltage regulator and 16MHz cristal oscilator. Arduino microcontrollers have programmed bootloader that simplifies process of transfer of translated program into flash memory on the microcontroller.

Arduino integrated development environment is application written in Java programming language. It is created such to be easy for use for programers. Arduino integrated development environment has C/C++ library called Wiring that makes input/output operations very simple to create. Arduino programs and applications are written using C/C++ programming language.

There are more versions of Arduino boards. Some of the boards are: Arduino Uno, Arduino Mega, Arduino Fio, LilyPad Arduino, Arduino Nano, Arduino Mini [3].

4. WI-FI WIRELESS COMMUNICATION TECHNOLOGY

Wi-Fi (or WiFi) is a term for wireless local area networks (WLANs) [4]. Wi-Fi is the technology for local area wireless computer networking using radio signal. It allows different devices to be connected in a network, mainly using the 2.5 gigahertz UHF and 5 gigahertz SHF ISM radio bands. The Wi-Fi Alliance defines Wi-Fi as any wireless local area network (WLAN) based on IEEE 802.11 standards [4]. The term Wi-Fi is used as a synonym for WLAN since most modern WLANs are based on these standards. Many devices use Wi-Fi, such as are personal computers, smartphones, digital cameras, tablet computers. These devices can be connected to a network resources and the Internet via a wireless network access point. Such an access point has a range of about 20 meters indoors and a greater range outdoors. Access point coverage can be as small as a single room or as large as many square kilometres achieved by using multiple overlapping access points.

In general WLAN consists of:

- more access points with wireless connection to Wi-Fi devices,
- wired distributive system connecting the access points into one network.

The distributive system is uselly connected to the Internet. Such, connecting to any access point of some WLAN, the user and the device have possibility to comunicate in the global Internet network. The Wi-Fi signal and network range is about 100 meters, but it depends on barriers for the signal. The

throughput of such networks is 54 Mbps. To be able to communicate in the network the device has to have appropriate adapter for Wi-Fi networks.

One of problems is that the Wi-Fi can be less secure than wired connections because an intruder does not need a physical connection to the network. Because of this, the Wi-Fi has adopted and uses various encryption technologies.

5. PRACTICAL IMPLEMENTATION DESCRIPTION

One system for control with the help of wireless communication and mobile phones was practically developed and implemented. The system enables to control lighting in the house by mobile phones. Arduino Uno development board and appropriate developed software for the board are used for implementation of the system. The Arduino Uno board acts as a system server. It is connected to Internet using Ethernet network board. Adjustment of needed lighting in the house, as well as lighting turning on and turning off, is implemented using mobile phone with Android operating system and appropriate developed application. Intensity of the lighting can be increased or decreased very simply from the mobile phone. In the system are also integrated a temperature sensor and an ultrasonic sensor. It enables to monitor temperature in the house and to monitor motion in the house, so that the house can be safe, and it functions like a house alarm. The lighting is set to work on 220 V/50 Hz and for the control are used relays. Figure 1 shows assembled Arduino Uno board and all other elements.



Figure 1. Assembled Arduino Uno board and all other elements.

To achieve proper operation and communication in the system it was needed to develop, write and implement appropriate program code that is executed on the microcontroller on Arduino Uno board. As an illustration a part of the server program code for the microcontroller is shown in Figure 2.

Code for the microcontroller

```
#include <SPI.h>
#include <Ethernet.h>
#include <Servo.h>
#include <dht.h>
```

```
#define dht_dpIn A0
#define trigPin 5
#define echoPin 4
dht DHT;

byte mac[] = { 0xDE, 0xAD, 0xBE, 0xEF, 0xFE, 0xED };
IPAddress serverIP(192,168,0,177);
int serverPort=80;
int state, statesv, staterel3, staterel4 ;

EthernetServer server(serverPort);

int oldPotiValue=0;
int led = 9;
int sv=8;
int rel3=7;
int rel4=6;
int alarm=3;
void setup()
{
.....
.....
.....
}
```

Figure 2. Part of server program code for microcontroller.

This program code enables to the microcontroller and Arduino Uno board to act as the server. The server accepts requests from the client (the user) side and answers to the requests or performs appropriate function initiated by the request.

When the code for the server part of the system is written it is also needed to develop, write and implement program code for the client part of the system, for the mobile phone with Android operating system. The client part program code enables the user to control the server part and control operation of the system. The client part of program code is written in Java programming language and was developed in Eclipse development environment. There are two types of program code in the client part, the code for the form and the code that controls the form (so called activity). The program code for the form is developed in XML language and the program code for the activity is written in Java language [5]. A part of the program code for the form in the client application is shown in Figure 3.

Code for the form

```
<?xml version="1.0" encoding="utf-8"?>
<RelativeLayout
xmlns:android="http://schemas.android.co
m/apk/res/android"
    android:layout_width="fill_parent"
    android:layout_height="fill_parent"
    android:orientation="vertical" >

    <Button
        android:id="@+id/button2"
```

```
style="?android:attr/buttonStyleSmall"
android:layout_width="wrap_content"

android:layout_height="wrap_content"

android:layout_above="@+id/btnRel3"

android:layout_alignParentRight="true"

android:layout_alignTop="@+id/btnOn"

android:layout_toRightOf="@+id/btnOn"
.....
.....
.....
```

Figure 3. Part of program code for form in client application.

Figure 4. shows the graphical appearance of the Android client application.

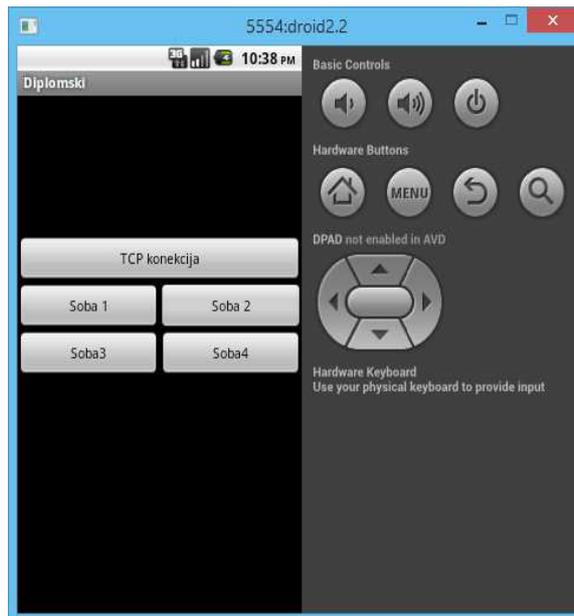


Figure 4. Graphical appearance of Android client application.

6. CONCLUSION

The paper shows the possibility and the way how easy to use wireless communication and mobile phones for different control applications. Practical implementation of control of lighting in the house and monitor temperature and motion in the house by wireless communication and mobile phone gives an example of simple and inexpensive realization of one such system. Wi-Fi wireless network is

chosen for the wireless communication because of its range. Also, Wi-Fi network enables easy connecting to the Internet network and such connecting of the house to the Internet network is enabled. When the house is connected to the Internet, it can be accessed from any other place that has Internet connection. Another reason that Wi-Fi wireless network is chosen instead of a wired one is that it is much cheaper for implementing. The costs of the maintenance of this kind of network are also lower because there are no cables to be damaged.

The practical implementation is consisted of the hardware part and the application software part. The hardware part is implemented using the Arduino Uno microcontroller board. Arduino Uno microcontroller board has been chosen because it is inexpensive and all of the other components are easily connected to it. There are many components made for the Arduino board that expand its abilities, various sensors, from those for temperature, humidity, to sensors that detect movement. There are also relays that enable to control devices no matter what voltage network they were made for.

The application part of the practical implementation has been realized in Eclipse development environment, the program code has been written in Java programming language and the operating system that the application has been run on is Android. Operating system Android has been chosen because of its open source code and its popularity.

7. REFERENCES

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