[1.]Zlatko BUNDALO, [2.]Nebojša RISTIĆ, [3.]Dušanka BUNDALO, [4.]Dražen PAŠALIĆ, [5]Branimir CVIJIĆ

POSSIBILITIES OF USING MOBILE PHONE FOR USER IDENTIFICATION

[1.]Faculty of Electrical Engineering, University of Banja Luka, BOSNIA & HERZEGOVINA
[2.]Aero Centar Krila d.o.o., Banja Luka, BOSNIA & HERZEGOVINA
[3.]Faculty of Philosophy, University of Banja Luka, BOSNIA & HERZEGOVINA
[4.]Sberbank a.d., Banja Luka, BOSNIA & HERZEGOVINA
[5.]Lanaco d.o.o., Banja Luka, BOSNIA & HERZEGOVINA

Abstract: Possibilities of using mobile phone as user identification device for access to systems, objects or services are considered, proposed and described in the paper. The elements of the mobile phone give possibility for mobile phone to be used as identification device and to substitute other types of identification elements. In this way the mobile phone can be used as communication and identification unit. Such way of using mobile phone is proposed and described in the paper. The method that is proposed and described is based on application of smartphone for user entering access data or access key. One practically implemented such system for user identification in control of access to object (garage or car parking), based on microcontroller platform and smartphone is proposed and described in the paper. For communication was used Bluetooth wireless technology. Results of functionality testing of the system are presented in the paper.
Keywords: smart mobile phone; user identification; user access to objects or services; access to garage or car parking; microcontroller based platform; Bluetooth wireless technology

1. INTRODUCTION

Mobile phones and smartphones are standard communication devices used by many users. Mobile phone is microprocessor based system with memories and different peripheral communication elements. Smart card or SIM (subscriber identity module) card in the mobile phone can memorize data about the mobile phone user and different identification data (user name, access passwords, access keys and other identification data). It gives possibility for mobile phone to be used also as identification device. Such, the mobile phone could replace and consolidate many identification elements, different types of cards and other elements for identification. The other identification elements are for example: identity card, driving license, health card, passport, student index, remote device for access to some area, remote device for access to a car, for entering sports events, public transport vehicles, for electronic payments, etc.

It is proposed here to develop and implement system which will enable mobile phone to be not only communication, but also identification device. Such can be avoided usage of other identification elements in many practical applications for user identification, for tracking and control of the user access to facilities, spaces and services using a standard mobile phone.

Practically developed and implemented system is proposed and described in the paper. The implemented system is based on Arduino microcontroller platform and smartphone with Android operation system. Bluetooth Low Energy (BLE) wireless technology was used for communication. The implemented solution is used for control of access to objects, for control of access to the car parking or garage. Only authorized users with appropriate identification data in their smartphone and with appropriate International Mobile Equipment Identity (IMEI) number of the smartphone can access to the object or service. The implemented system is connected with computer of PC type. It enables implementation of monitoring of user presence in the object and memorizing and processing of such obtained information and data.

In order to increase reliability it is also needed to performe authentication of the identified user. There are three used authentication methods based on: something that the user knows (password, key word, etc.), something that the user owns (key, token, etc.), something that the user is (voice, fingerprint, etc.) [1]. Implemented system combines the first two methods: something that the user knows (user name and password) and something that the user owns (smartphone with appropriate IMEI number) [2].

2. SMARTPHONE IN IDENTIFICATION OF USERS

One of basic and the most important features of the mobile phone is portability allowing it to be permanently close to the user, representing such an ideal means for user identification.

Hardware architecture of the smartphone is different from x86 or x64 processor architecture. Therefore, there

are significant differences in the architecture of the CPU for use in smartphone [3,4].
The smartphone has operating system as an integrated component [3,4]. The most commonly used mobile operating systems for modern smarthones are: Google Android, Apple iOS, Nokia Symbian, RIM BlackBerry, Samsung Bada, Microsoft Windows Phone.
The application is a part of smartphone software that provides additional features for smartphone [3,4]. Using the application user adds needed functionality to smartphone.
Bluetooth Low Energy (BLE) and Near Field Communication (NFC) are wireless technologies convenient for transfer data between the smartphone and other systems [5,6]. The designers should to choose the one that meets their needs. The BLE wireless technology was used for the practically implemented system. The most important advantages are reduced power consumption and low cost. The advantages and great practical presence were reasons for selecting BLE wireless technology for communication between mobile smartphone and Arduino board based system in the implemented system.
Every day users carry many identification cards and devices. All these identification elements are often of different shape and production. That complicates activities that require identification. A large number of identification elements can be integrated into mobile phone. It is much easier for users to carry just one mobile phone with all identification data for all identification systems they use than to carry a variety of different elements for identification. Also, the risk of forgery and malversation decreases in case of losing or stealing of the identification resources that have any kind of "intelligence" (as mobile phone has).

3. IDENTIFICATION SYSTEM IMPLEMENTATION

Here is described proposed practical implementation of user identification system using smartphone for entrance to the garage or to the car parking space. Structure of the implemented system is shown in Figure 1.

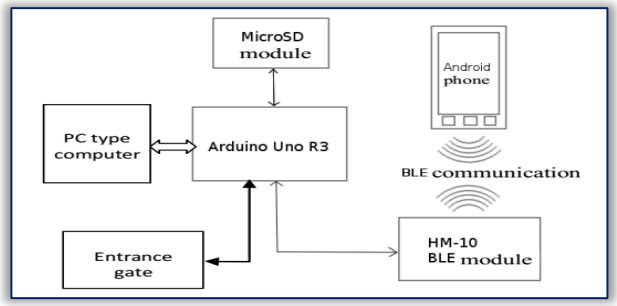


Figure 1 - Structure of implemented identification system

It was used smartphone with the Android operating system for entering the user data for identification at the entrance. The microprocessor Arduino Uno R3 platform with ATmega328P microcontroller was used for checking and control of the identification and for the user entry approval. The mechanism for opening or closing entrance gate is connected and controlled by the Arduino platform. User enters username and password using Android application on the smartphone. The identification data transfers via BLE wireless technology to the Arduino platform located in the access point. The smartphone IMEI number also transfers in the same time. Valid identification data including IMEI number is stored on the MicroSD card. The program on the Arduino platform checks out entered user data. The user was successfully identified and obtained permission to access the garage or the car parking and entrance gate is opening if the sent user information is correct (matches with the user data stored on the MicroSD card). In the opposite case the access is not allowed. Arduino platforrm is connected with PC type computer. All information about users, their accesses, presence, permisions and other data are memorized and kept and can be analized on the PC computer.
MicroSD module was used to memorise the valid user data. Such is avoided entering identification data in Arduino program. It is also allowed to easily add, delete and update the data using any device that can work with SD card (mobile phone, computer, etc.). Also, user identification will not be possible if the SD card be removed from SD module. It can serve as a mechanism to forbid the further use of the system.
HM-10 BLE wireless module using BLE Bluetooth technology performs communication and data exchange with Android based smartphone.
There are also two LEDs connected to Arduino board indicating state of the identification and state of the entry gate. It was used Arduino IDE development environment for development of the system [7,8]. Programing was made using Arduino programing language very similar to C^{++} programing language [7,8]. It was used Android Studio for development of Android application [9].
The implemented programs consist of two parts: program for the Arduino board and application program for Android smartphone. Arduino program part accepts commands from mobile phone and returns responses. Arduino program also controls all elements connected to the Arduino board. Part of that implemented program is shown in Figure 2. Android mobile phone program part processes obtained answers and interacts with the user. Part of the implemented program is shown in Figure 3.
While the user is not identified and login it can use next command from Android mobile phone:

- login – initialization of the identification process (when the user is identified the LED 2 is turned on).
- After identification the user can use the following commands:
- enabling access – command to indicate identified user and enabling that the access be enabled and open (open entry or access, this command turns on LED 1),
- disabling access - command to indicate that the user has left the space or service and that the access be disabled and closed (closed entry or access, this comand turns off LED 1),
- access status – command that returns information is entry enabled (open) or disabled (closed), that the LED 1 is on or off,
- logout – comand with which the user interrupts and stops status of identified user and logout from the system (the LED 2 is turned off).

```
//main loop block
void loop() {
  if(Serial.available()) // if data on BLE module serial avaiable
  {
    line = readLineSerial(); // reading 1 line of text from BLE serial
    mySerial.println("Arduino received line: "+line); // printing status to serial port used for debugging
    if(line == "login"){ // if received line of text equal to "login" string
      Serial.print("OK"); // returning string over ble to notify that command "login" received

      //waiting to receive username
      int c = 0;
      while(c < 1000){ // if time for reading username not expired
        if(Serial.available()){ // if data on BLE module serial avaiable
          username = readLineSerial(); // reading username from BLE serial
          mySerial.println("username line: "+username); // printing status to serial port used for debugging
          break; // if username acquired stop looking for username and proceed
        }
        c++;
        delay(10); // delay of 10ms
      }

      if(c >= 1000){ // if time expired
        Serial.print("ERROR TIMEOUTu"); // sending error about timeout on ble serial
      }else{
        Serial.print("OKu"); // sending string that reading username is successful over BLE serial
      }

      //waiting to receive password
      if(c < 1000){ // if reading password is not timeout
        c = 0;
        while(c < 1000){ // if time for reading password not expired
          if(Serial.available()){ // if data on BLE module serial avaiable
            password = readLineSerial(); // reading password from BLE serial
            mySerial.println("pass line: "+password); // printing status to serial port used for debugging
            break; // if username acquired stop looking for password and proceed
```

Figure 2 - Part of implemented Arduino application program


```
//main loop block
void loop() {
  if(Serial.available()) // if data on BLE module serial avaiable
  {
    line = readLineSerial(); // reading 1 line of text from BLE serial
    mySerial.println("Arduino received line: "+line); // printing status to serial port used for debugging
    if(line == "login"){ // if received line of text equal to "login" string
      Serial.print("OK"); // returning string over ble to notify that command "login" received

      //waiting to receive username
      int c = 0;
      while(c < 1000){ // if time for reading username not expired
        if(Serial.available()){ // if data on BLE module serial avaiable
          username = readLineSerial(); // reading username from BLE serial
          mySerial.println("username line: "+username); // printing status to serial port used for debugging
          break; // if username acquired stop looking for username and proceed
        }
        c++;
        delay(10); // delay of 10ms
      }

      if(c >= 1000){ // if time expired
        Serial.print("ERROR TIMEOUTu"); // sending error about timeout on ble serial
      }else{
        Serial.print("OKu"); // sending string that reading username is successful over BLE serial
      }

      //waiting to receive password
      if(c < 1000){ // if reading password is not timeout
        c = 0;
        while(c < 1000){ // if time for reading password not expired
          if(Serial.available()){ // if data on BLE module serial avaiable
            password = readLineSerial(); // reading password from BLE serial
            mySerial.println("pass line: "+password); // printing status to serial port used for debugging
            break; // if username acquired stop looking for password and proceed
```


Figure 3 - Part of implemented Arduino application program

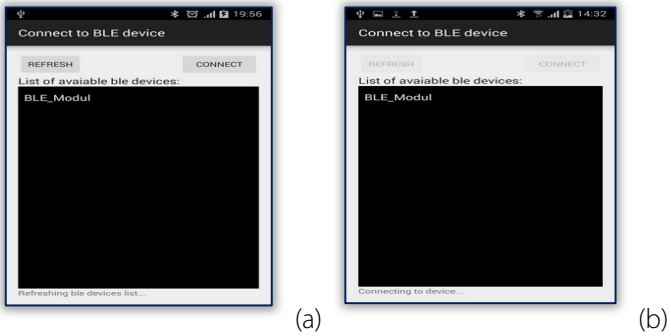
Android application program on smartphone consists of three parts.

The first part scans whether there are active BLE devices. If there are near active BLE devices they will appear in the list of devices on what can user be connected. When device from the list was selected and the connection process started by pressing button "CONNECT" the second part of application program is started.

In the second part of program the user enters his identification data (username and password). The process of identification begins when the user enters the data and press the button "LOGIN". User smartphone IMEI number also transfers in the same time. If the user enters wrong data or if IMEI number is wrong, user will receive message about wrong identification and will be forbidden system usage. If the transferred data are correct the user is identified and goes to the third part of the application program.

The third part of program is the area in which the user can stay or leave the state of identified user and return to the second part of the application program.

The application on Android mobile phone performs interaction with Arduino based part for identification. The list of BLE devices to which users can be connected appears after starting Android application. Also, it can be re-activated the scan by pressing the button "REFRESH" to find BLE devices that were later entered into the range of a mobile phone or previously were not found for some reason (Figure 4a).



(a) (b)

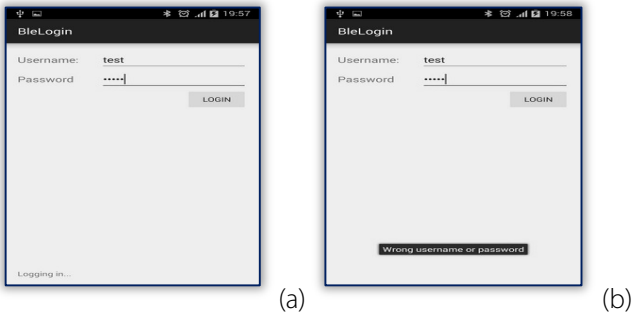
Figure 4 - Refreshing of BLE devices list (a) and connection to selected BLE device (b)

By selecting one of the devices from the list it was choosen and marked that device. By press on the button "CONNECT" connection with the selected device is performed (Figure 4b). If the user was not chosen any device it will be displayed the message "Please select device from list to connect".

After the application connects to the BLE device it goes to the login form and begins identification of the user (Figure 5a). On this form the user enters username and password. By press on the button "LOGIN" it is done

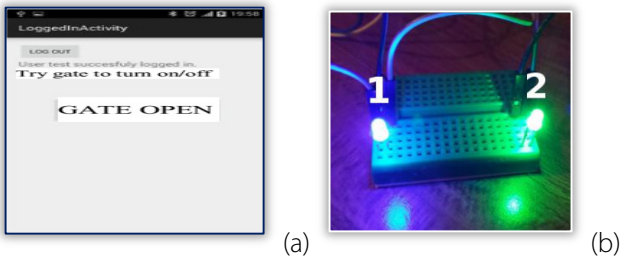
sending of the user data including IMEI number to the Arduino system (Figure 5a). If the user sends wrong data he will receive an error message (Figure 5b).

If identification was successful the user is login on the system and in Android application. The LED diode (LED 2) connected to output of Arduino board turns on (indication of user identification). Then the user goes on the form where he can control entrance gate and control the LED diode (LED 1) also connected to output of Arduino board (indication of access control). Smarthphone display form for the case when the user is identified and login is shown in Figure 6a. Arduino indication when user is login (LED 2 is on) and the entrance gate is open (LED 1 is on) is shown in Figure 6b.



(a) (b)

Figure 5 - User started with login process (a) and user entered wrong user data (b)



(a) (b)

Figure 6 - Smartphone display login user form (a) and user login and open entrance gate Arduino indication (b)

4. CONCLUSIONS

Due to small size, ease of use, low cost and ease of portability mobile phone has one of leading positions for performing various user operations and activities. In many systems there is need to protect data and information from unauthorized use. Here is proposed to use mobile phone as device for user identification. Mobile phone can replace many identification elements with one device that every day is with the user.

The identification by using Android mobile phone, Arduino platform based system and BLE wireless technology was proposed and described in this paper. The implemented system shows that such use of smartphone and the wireless communication can highly simplify user daily life and business operations and reduce costs. Simply, by using smartphone for identification it can be enabled to access to perform complex operations and send and receive various data. Used technology is cheap and available. The system is universal. It could be used in various fields where it is performed identification, monitoring and control of access to the facilities or premises, or control to access to certain services. With small modifications it could be adopted for application in other needs. To avoid misuse of the system by unknown and unwanted person it is used smartphone IMEI number.

It can be expected and concluded that in the future will be increase of needs for user identification and for improving efficiency and quality of the process. Mobile phones will play one of major role in the process of user identification because of its functionality and presence among the users. Implemented system is very convenient because with just one smartphone can enabled very secure access for many and almost infinite number of access points with needed user identification. One smatrphone can be used to access the apartment or house, car, workplace and many other objects, facilities, areas and spaces. Also, the BLE technology with its advantages seems to be now the best wireles technology for use in such systems.

Acknowledgment: This paper was supported by the Ministry of Science and Technology of Republic of Srpska, Bosnia and Herzegovina, through the project "Development and implementation of systems for user identification when accessing objects using mobile phone".

References

[1] NIST Computer Security Handbook, http://www.sos.cs.ru.nl/applications/courses/security2008/nistiadraft.pdf
[2] Official Web site of GSMA, http://www.gsma.com/managedservices/mobile- equipment-identity/about-imei/
[3] R. Kumar, L. Pawar, A. Aggarwal: Smartphone's Hardware Architectures and Their Issues, Int. Journal of Engineering Research and Applications, Vol. 4, Issue 5, May 2014.
[4] M. P. Singh, M. K. Jain: Evolution of Processor Architecture in Mobile Phones, International Journal of Computer Applications, Vol. 90, No 4, March 2014.
[5] K. Townsend, C. Cufí, R. Davidson: Getting Started with Bluetooth Low Energy, O'Reilly Media, 2014.
[6] T. Igoe, D. Coleman, B. Jepson: Beginning NFC: Near Field Communication with Arduino, Android, and PhoneGap, O'Reilly Media, 2014.
[7] M. Schmidt: Arduino A Quick Start Guide, Pragmatic, 2011.
[8] J. Blum: Exploring Arduino: Tools and Techniques for Engineering Wizardry, John Wiley & Sons, 2013
[9] J. Annuzzi, L. Darcey, S. Conder: Introduction to Android Application Development, Addison-Wesley, 2013.