JIEE Časopis priemyselnej elektrotechniky
Journal of Industrial Electrical Engineering
ISSN 2454-0900
www.jiee.eu

Design of a smart wireless doorbell

[1]*Anna HODULÍKOVÁ*, [2]*Richard MAKO*

[1,2] Department of Theoretical and Industrial Electrical Engineering, Faculty of Electrical Engineering and Informatics, Technical University of Košice, Slovak Repablic

[1]anna.hodulikova@tuke.sk

Abstract — **The aim of the research presented in this paper, was to design a wireless doorbell that would have non-standard features, e.g., photo-gallery of visitors in the website archive and e-mail notifications of the owner on the visitors ringing the bell. Three technologies - Arduino Nano, Raspberry and PHP were used for the construction of a wireless doorbell. Raspberry module directly communicates with the server, where the photo-gallery of visitors is saved. The server also works as an e-mail sender of notification e-mails messages. Radio wave communication technology was used for a wireless communication between Arduino and Raspberry modules, and Wi-Fi technology was used for the communication between Raspberry module and the server. The use of this doorbell is very economical and it could conspicuously increase the safety and comfort of the owner.**

Keywords **— Raspberry, Arduino Nano, PHP, E-mail, Wi-Fi, Radio communication**

I. INDUCTION

Technological advances make it possible to increase the safety of buildings. Wireless bell with additional features [1], [2], [3] is one of the commonly used devices that can increase the security of owners. For individual users, the low prize of a security device and its running is important. On the other hand, using of such device should by simple.

The article presents a new original way for creating cheap home smart wireless doorbell using on the market currently available Arduino and Raspberry components as well as connection to Internet. Specific communication architecture and original design structure which enable non-standard additional functions of a doorbell are proposed: creation of a photo-gallery of visitors in the website archive and e-mail notifications of the owner about the visitors who have rang the bell.

The proposed smart doorbell system is stable, reliable, and its cost is relatively low. Each device module can be customized by user according to his preferences or it can be modified and used as a part of other similar devices.

II. DEVICE IMPLEMENTATION

The proposed smart doorbell consists of a standard doorbell which is connected to other devices which gives it some additional functions.

A. Device features

The device includes a camera that takes the picture of the person after ringing the bell and it saves it to the memory. An Internet connection that is addressed by add-on Wi-Fi module (possibly Ethernet) provides image transfer for further use.

To make the doorbell creative and interesting for the end consumer the information about visitor has to be available remotely. For this reason, visitor's image is sent to the server where it is saved to the database of persons ringing the bell. Simultaneously, to achieve maximum effectiveness, an e-mail message which includes the visitor photo with time and date is sent to the owner. In this way, the owner is kept informed about missed visitors.

E-mail messages are the best option for the owner notification due to several reasons. Sending e-mail messages is free of charge if there is a connection to the internet in the house. Other possible options of connection via the internet as GPRS or GSM notification would require additional costs for the user. Another reason for using e-mail messages is the easy access to the owner mailbox anytime and anywhere (in contrary to the short message service which could provide other options but archive is not included). The e-mail provides two types of notifications in one since in addition to e-mail message itself, it archives all messages. The owner can use e-mail client on his mobile device to pair with his home device and he will be notified about visitors through his mobile phone everywhere if he has the access to Internet [4].

B. Device desing and contruction

In order to create the device with above mentioned features it was necessary to interconnect several systems (ringer, wireless, camera, internet, e-mail) which should be compatible. It was necessary to analyse and select systems and components that have all these functions and they are fully compatible with each other [5].

As the main module of the proposed smart doorbell it was used the model of one chip boards from Raspberry. The improved model Raspberry Pi B + has the same layout and design as the original version, and the only change is a low noise power delivery, the doubled number of USB ports for a total of four, 40-pin GPIO interface that replaces the previous 26-slot, Micro SD slot [6], [7].

The proposed smart wireless doorbell, like any other doorbell, consists of two main parts. The first one is the transmitter. This module is based on the Raspberry technology – the Raspberry Pi B + single-chip board described above. All essential elements of the proposed smart doorbell project are connected to the Raspberry board, which is a part of the device, which contains the button, Fig. 1.

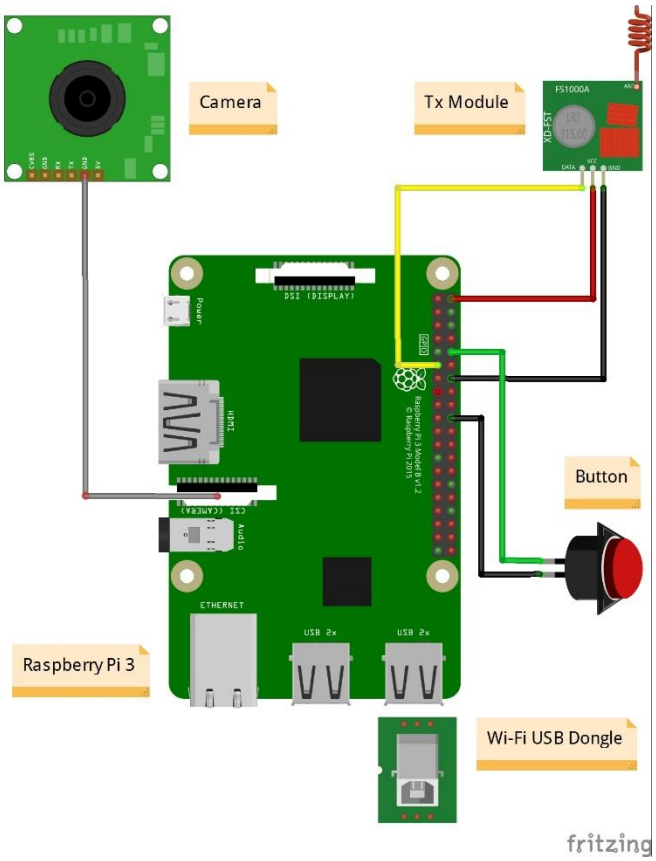

Fig. 1 Wiring diagram of transmitter

There is also an internet connection - to send images and data to a remote server, the radio signal transmitter for signalling tone and communication with the second module, and the camera that takes pictures of the person who pressed the button. The module supports an internet connection wirelessly through Wi-Fi and it can be wired to Ethernet [8].

The second part which is a secondary module is the receiver module, in which as the main single-chip motherboard is Arduino Nano board [9]. This board, in addition to the usual built-in features, includes a speaker for signalling tones and radio signal receiver that communicates and receives signals from Raspberry main module, Fig. 2.

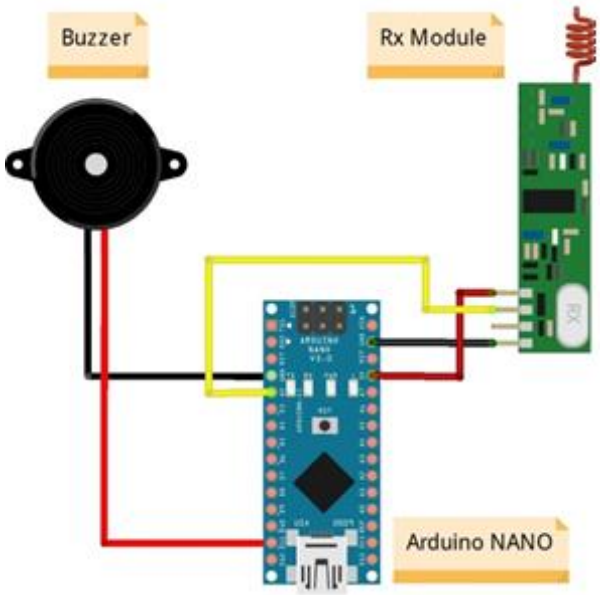

Fig. 2 Wiring diagram of parts of receiver

Communication between modules requires wireless radio communication which is provided by a simple radio receiver and transmitter connected to the Arduino and Raspberry. Radio transmission of ringing for the purpose of notifying is mediated using 433MHz radio transmitter connected to the Raspberry through GPIO ports, Fig. 3.

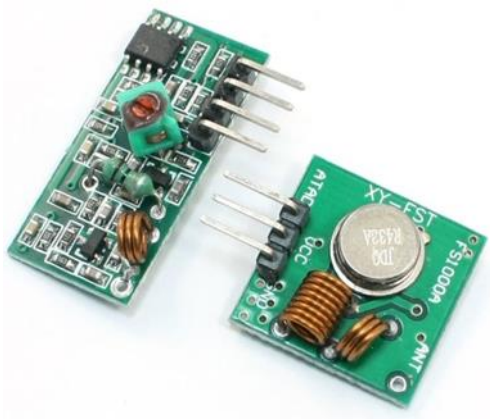

Fig. 3 Used modules RX and TX 433 MHz

Transmitter is connected to Raspberry using three outputs to the transmitter Raspberry GPIO ports, particularly in our case GPIO port 17 (11) as a data port, port 2 as a power Vcc to 5V input and port 14 as a ground. Raspberry in its default configuration does not recognize and it cannot use a radio transmitter, therefore it has to be configured to recognize transmitter and for proper load of used pins. This requires two official libraries, *Wiring Pi* and *rcswitch-pi*, to be installed in Raspberry which are available to download and free to use. The first library is *Wiring Pi* and it numbers GPIO ports. *Wiring Pi* library is a prerequisite for the proper functioning of the radio port. It ensures the proper working and reading individual GPIO port interface. Installing library itself consists in a series of commands that have to be entered into the console Rasping after connecting through remote control. The second one is *rcswitch* library, which ensures ability of the above mentioned GPIO ports to communicate with the control software.

C. The notification and Gallery

The proposed smart doorbell provides three kinds of notification: a ringtone, an e-mail notification about visitor and the database of ringing persons. Photo gallery of the last 12 visitors is stored on the server, together with the time and date of their visit.

After opening the website, the homepage can be seen, where the current connection status of the bell (online / offline) is indicated, together with its current IP address and, if offline status, the date of the last connection and IP address.

Except the state there is also a preview page that shows the most recent record of the bell, i. e., a recent photo of the person who rang the bell, along with time and date, Fig. 4.

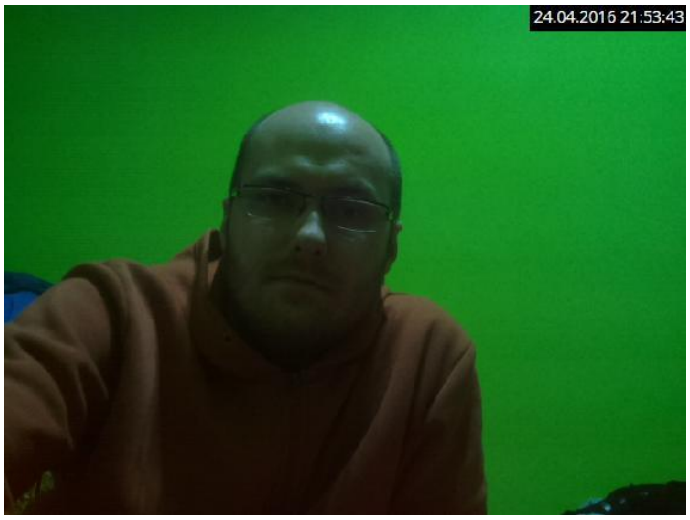

Fig. 4 Home page Gallery (archive) containing photo of the last ringing person, doorbell current connection status with an IP address and a link to the archive and other photos

Gallery (archive) is created using PHP page that contains scripts to store and to display the current connection status of the bell, Fig. 5.

Fig. 5 Gallery of last 12 photos with time and date

The core of the website is index.php file. This file is using another file get_status.php to display the state on the main page. The last picture shown on the main page is provided by a script get_last. php. The script chooses the newest saved picture from camera recordings and it shows it on the main page, Fig. 4. The second important part of the whole page is detail.php file, which is in charge of the entire archive of all the last 12 photos that it picks from the photo database and displays them in a glimpse of the photo album along with their time data, Fig. 5.

The last but the most important part of PHP page, is the owner e-mail notification that somebody pushed the doorbell, Fig. 6. PHP can send e-mails directly from the site by using an additional library that must be installed on the server. "Mailer" library allows ".php" scripts to send e-mails directly through the script. Although PHP has an option to send e-mails without using this library, its use makes sending of an e-mail message with an attachment (the photo of a visitor, Fig. 7) much easier.

Fig. 6 An e-mail notification on a mobile phone

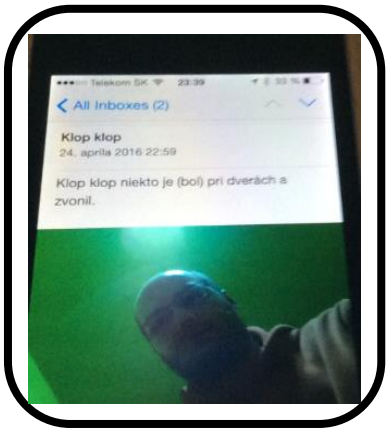

Fig. 7 An e-mail notification with the visitor photo using e-mail application in the mobile phone

This e-mail notification can be set on the mobile device, tablet, phone or smartphone, so the owner can be alerted about a visitor anywhere [10]. Examples of e-mail notifications on a mobile phone are shown in Figs. 6 and 7.

III. Conclusion

A wireless doorbell, which in addition to its standard function – ringing – has other functions, was designed and implemented. The owner can receive e-mail notifications that someone is ringing at his door, and he can visit a website where he can browse through the archives (Photo Gallery) and see the photos of the last visitors.

The doorbell was assembled using two most popular single-chip boards Arduino Nano - which serves as a receiver of signal tones and it includes a speaker for notifying tones in the interior and Raspberry Pi B +, which acts as the main module and transmitter, which includes a camera for taking pictures of visitors (ringing the bell) and Wi-Fi adapter for wireless connection to the internet and then for sending photos to the web archive. The main problem solved within the project was to conceptualize the roles of the modules and to find two modules that both perform their roles perfectly and they are compatible with each other as well as with other peripheral devices.

An interesting complementary feature is linking the bell to the online world and online archives which can inform the owner via e-mail message and they can provide real-time information about visitors via e-mail message with attached photos. On the other hand, using archive and/or e-mail the owner can check missed visitors also from places, where no signal for mobile phone is present, or where mobile phone use is rather costly.

Using similar principle the owner could adapt the system to any other form of notification. Without major adjustments it might provide, for example, notifying SMS / MMS messages, or use of any one of today's modern "messenger".

The proposed wireless doorbell could be of a wide use. The system is stable, reliable, inexpensive, and it can be customized to the owner preferences very easily.

Acknowledgment

The support by the project VEGA grant No. 2/0069/15 of the Scientific Grant Agency of the Ministry for Education of the Slovak Republic is acknowledged.

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