Intermediate Project

Before You Leave

Author:
Kamil Drewniak

Instructor:
Witold Paluszyński, PhD
Faculty of Electronics, Photonics and Microsystems
Wrocław University of Science and Technology

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Abstract:

The goal of the project was to create a small electronic device which reminds the user about things that should be taken before leaving the home (for example: car keys, wallet, etc.) and will remotely notify him in case of forgotten item.

The device should be able to detect items, check if the user left the house, and send remote notification.

In the end the project was successful and the created device meets all of the project requirements.

1 Introduction

The goal of the project was to create a small electronic device that will remind user about things they should take with them when leaving their home (for example: car keys, wallet, mask etc.). The initial design of the device is shown in figure 1.

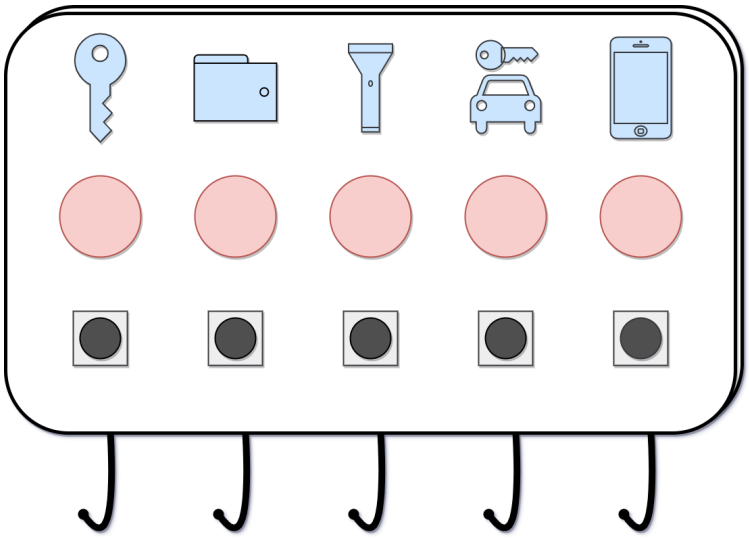


Figure 1: Initial design of the device

In the assumptions the device could be hanged on the wall near home entrance. On the bottom there would be series of hooks which allows to hang different items. On the front there would be series of red LEDs – each for one hook. When the device detects item hanged on the hook it would light appropriate red LED to indicate that this item should be taken.

Finally the device would be equipped with wireless communication that would allow it to notify the user in case they leave the home without one of the items (for example by phone notification).

Additionally each pair of hook and LED would have push button which would allow to manually override the status – this would be used to tell the device that user intentionally leaves one of the items and does not want to be notified about it.

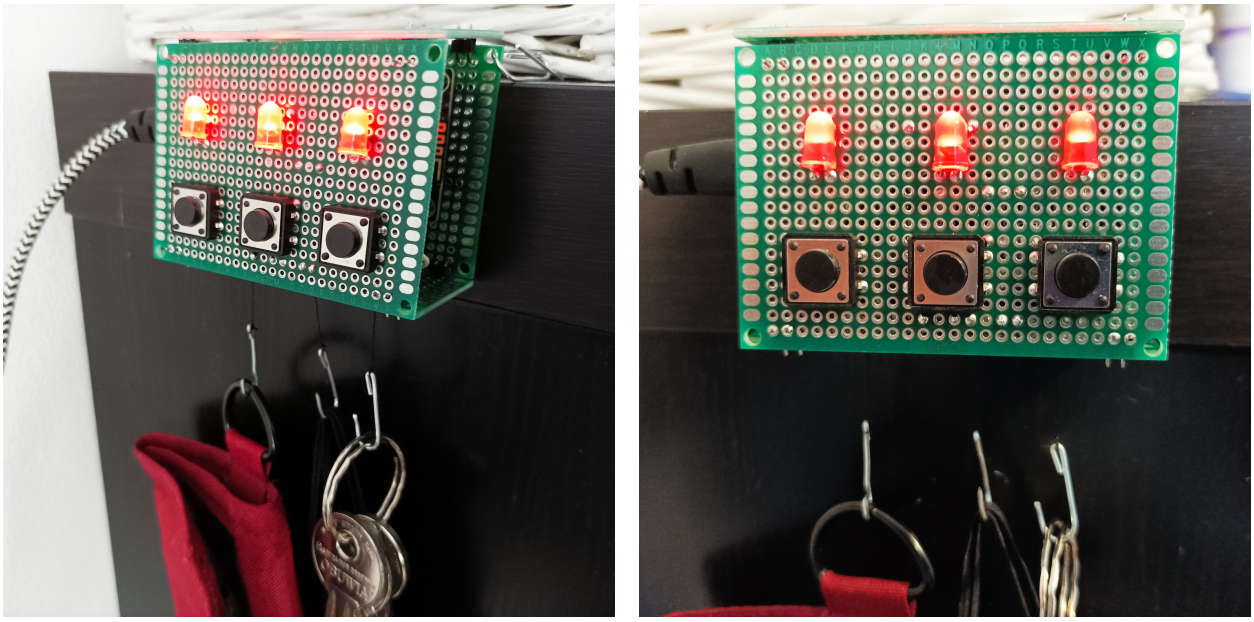
2 Results

The device was constructed successfully. In the end the number of items was limited to three, and the images in the front representing the items were removed to provide more flexibility when using the device. The photo of real device is shown in figure 2.

The details about the construction are described in next subsections.

2.1 Hooks mechanism

The hooks mechanism changed several times during the development of the project. The considered designs are described below.



(a) Side of the device

(b) Front of the device

Figure 2: Photos of the created device

2.1.1 Strain gauges

In the first version the hooks mechanism was supposed to be based on strain gauges. They can detect very small change of strain induced by items with weight of just a few grams. Unfortunately to properly use the strain gauges it is required to build special circuit with temperature change compensation and amplifier. Doing this for all the hooks would require a lot of additional space for the device.

2.1.2 Limit switches

The second version of the hooks mechanism was created with simplicity in mind. It simply uses a small limit switch with lever that can be connected to hook using string. When the hook is loaded with weight the limit switch is pressed and the change can be detected by the device. The biggest issue with this design is that it is impossible to control the force required to activate the switch. This means that the device might have problem with detecting very light items.

2.1.3 Springs

To solve the problem with light item detection using limit switches another design was considered. It was supposed to work using a spring. One side of the spring would be fixed to the device, and the other to the hook. When an item would be hang on the hook the spring would extend. The moving end of the spring would have metal part that would touch specially placed contact points which in result would close a electronic circuit. By using especially loose spring and minimizing the distance that it has to travel it would be possible to detect very light items hanged on the hook.

This idea required some custom made parts, like special case for the whole design with properly mounted spring and the metal contact parts. The special case was supposed to be 3D-printed but unfortunately it was impossible due to the unexpected failure of the 3D-printer.

Because of this the final version of the device uses the simple, but not perfect, limit switches solution.

2.2 Wireless communication and occupancy detection

The wireless communication was achieved by use of the ESP8266 microcontroller. The microcontroller was programmed in a way that allows it to connect to user defined Wi-Fi network and then use it for occupancy detection and remote notification.

When the device is launched for the first time it creates an access point (hot-spot) with given name and password. The user can connect to it and use special web browser address to access a configuration site. There it is possible to define name and password to the Wi-Fi network that will be used by the device. The user has to also define and IP address of mobile phone which will be used for occupancy detection. After that the device saves these information in memory – this allows it to automatically connect to the defined network later.

After the configuration, the device enters a mode in which it periodically checks if an item was left at home. Photo of the device with one item left at home is shown in figure 3.

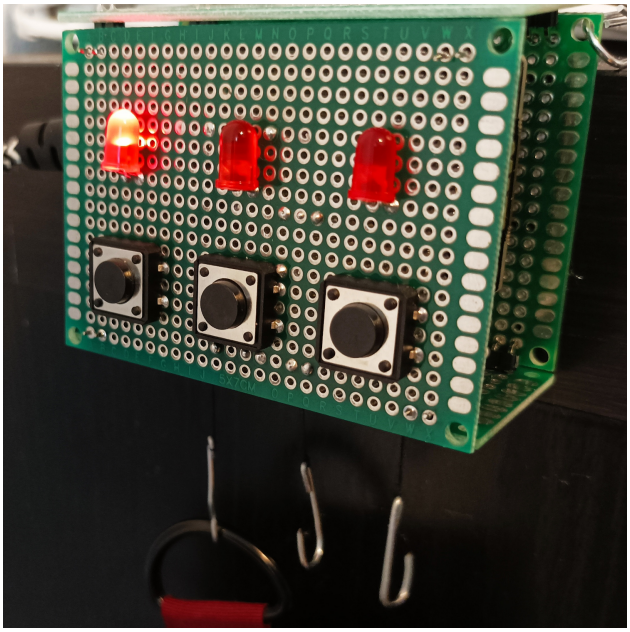


Figure 3: Photo of the device with one item left at home

To mark an item as missing a few requirements must be fulfilled:

1. Item must be detected as hanged on hook – this is done by use of the reading from the limit switches described above.

2. The override for given hook must be off – the override is a state in which the user pressed a button. This is an information for the device that the user intentionally leaves one of the items and does not want to be notified about it. Each of the hooks has its own button for this purpose.

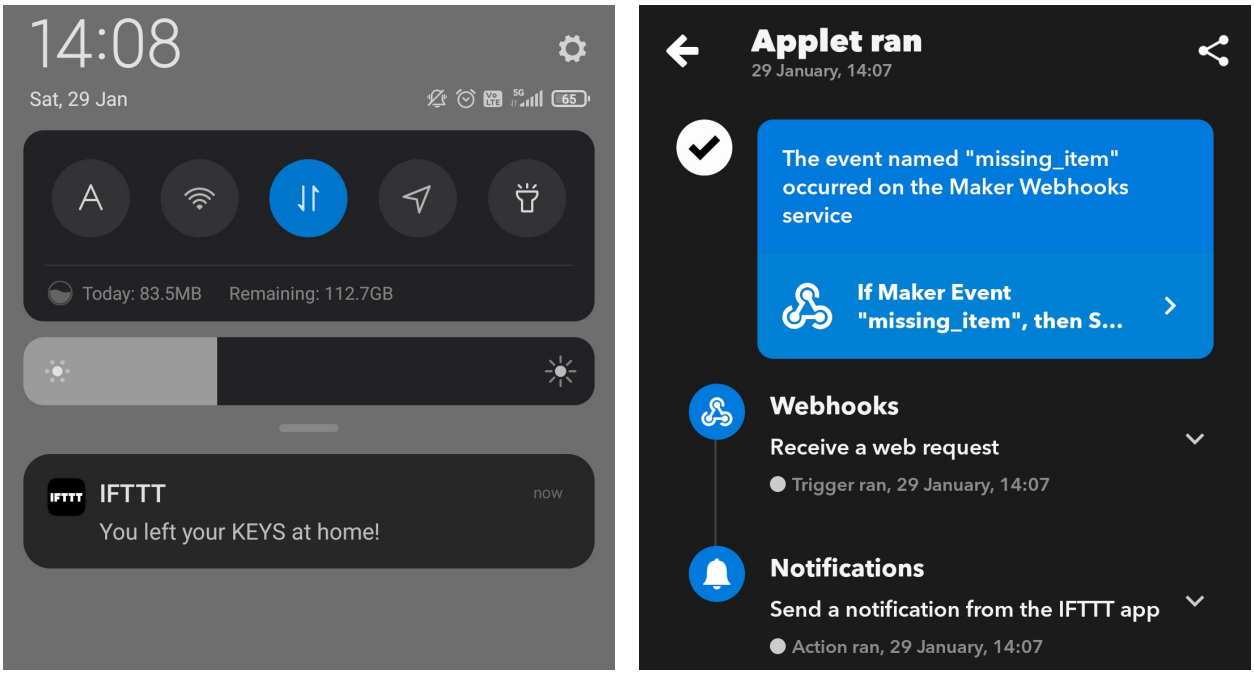
3. The occupancy detection must mark the user as not in home – this is done by use of the Wi-Fi network used by the device. The device pings previously defined IP address (which is

the user mobile) which is assumed to be connected to the same Wi-Fi network. If the mobile does not respond the device marks the user as not at home. The idea of this method comes from [1].

If all of the above conditions are fulfilled the device triggers a remote notification. The notification is described in next subsection.

2.3 Remote notification

The remote notification system uses the IFTTT service [2]. IFTTT (If This Then That) has connection with many different services which makes is possible to create simple automation tasks. In the case of this project a simple event for a special HTTP request was created. When a specially defined web address gets a request the IFTTT service triggers a notification via its mobile application. The only requirement is that the user must have the application on their mobile phone. The example effect and details of the notification are shown in figure 4. More about the usage of IFTTT services with ESP microcontrollers can be read in [3] and [4].



(a) Notification on the user mobile

(b) Details about the notification in IFTTT app

Figure 4: Remote notification effect and details

2.4 Hardware and Software

The device was given unique look by using the prototype electronic boards not only for the wiring, but also as the case of the device. Evaluation of the result of this procedure is left to the reader.

The electronic diagram of the device was created using KiCad software [5] and is shown in figure 5.

The code for the ESP8266 microcontroller was written in Visual Studio Code [6] with the help of PlatformIO [7] extension. The developed code is available in GitHub repository at `https://github.com/Wirgiliusz/BeforeYouLeave`.

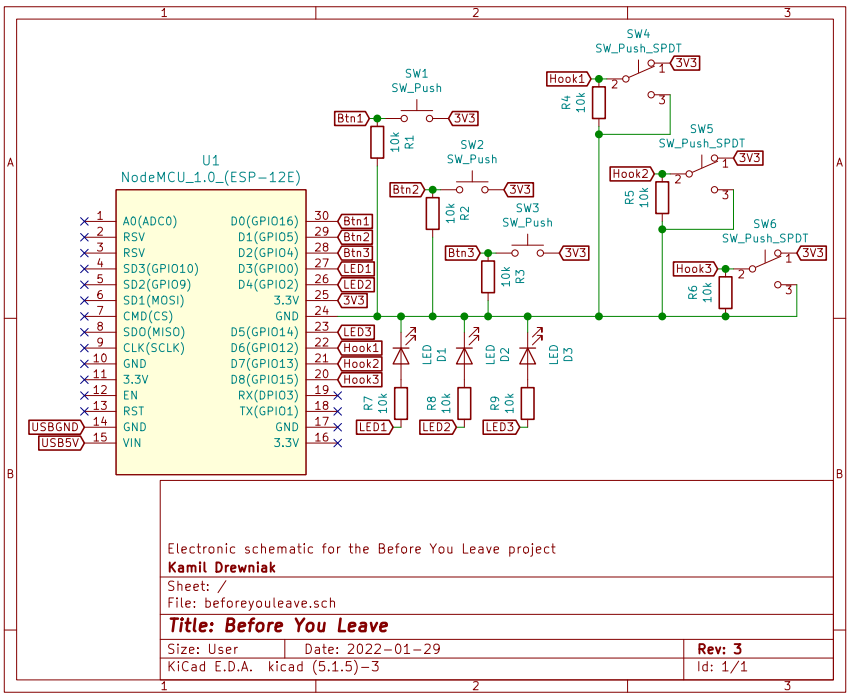


Figure 5: Electronic diagram of the device

3 Summary

Overall the project was a success. All the main goals have been met and all the assumptions were satisfied. To finish the projects it was required to do research about ESP microcontrollers programming, item detection (by weight), occupancy detection, wireless communication, and remote notifications. In consequence it allowed to learn new things and use the knowledge to turn it into real working device.

References

[1] WHITEPAPER. *Occupancy Detection Methods.* `https://www.softserveinc.com/en-us/resources/occupancy-detection-methods`

[2] IFTTT. *If This Then That official website.* `https://ifttt.com/`

[3] Najad. *IoT Motion Sensor – ESP 01 + PIR.* `https://www.hackster.io/najad/iot-motion-sensor-esp-01-pir-26a1fb`

[4] Karol Duszczyk. *Praktyczny poradnik łaczenia ESP z IFTTT (if this, then that).* `https://forbot.pl/blog/praktyczny-poradnik-laczenia-esp-z-ifttt-if-this-then-that-id41663`

[5] Kicad. *KiCad official website.* `https://www.kicad.org/`

[6] Visual Studio Code. *Visual Studio Code official website.* `https://code.visualstudio.com/`

[7] PlatformIO. *PlatformIO official website.* `https://platformio.org/`