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2. **Subject name/title: Device for wireless sound transmission**

3. **Summary - synthetic subject presentation**

We built a device for wireless sound transmission. It consists of two main modules: the microphone module for picking up the sound and the speaker module for broadcasting. The two parts communicate via Internet, therefore granting great mobility.

4. **Introduction - generalities, utility, resources**

Nowadays, the society is characterised by mobility. Everyone wants to be connected with the others or the environment but without all the cables. We witness an increase in the production, development and use of wireless devices.

We decided to be part of this trend and thought of transmitting speech to different locations while being restricted solely to Internet access. What could be the utility of this idea? Uses of it could include: a baby monitor - the microphone module in your baby's room will continuously transmit the sound it picks and you are therefore always up to date with what happens, a worldwide speaker - you can broadcast messages to your family while in different parts of the world , an educational module - you could introduce children, pupils and students in a rather interactive way to how (wireless) communication works, what protocols can be used, how sound can be processed and altered. The advantage is that the prototype is very versatile and only imagination is the limit. The simple version would imply transmitting the picked sound, while adventurers could go in the depths of sound processing and altering, problems encountered with real-time transmission etc.

The used resources in the development of this project were:

- ARM XMC1100
- ARM XMC4700
- Electret Microphone Amplifier - MAX9814 with Auto Gain Control
- HC-05 Bluetooth Module
- Raspberry Pi 2 with Wi-Fi module
- Raspberry Pi 3 Model B

5. Solution description, implementation details

The idea behind the solution is depicted in the following figure (Fig.1). The user talks for the microphone module and his words are transmitted over the Internet to the speaker module where a second user can listen.

Fig.1 Schematic description of the device

The two modules are described and illustrated below (Fig.2).

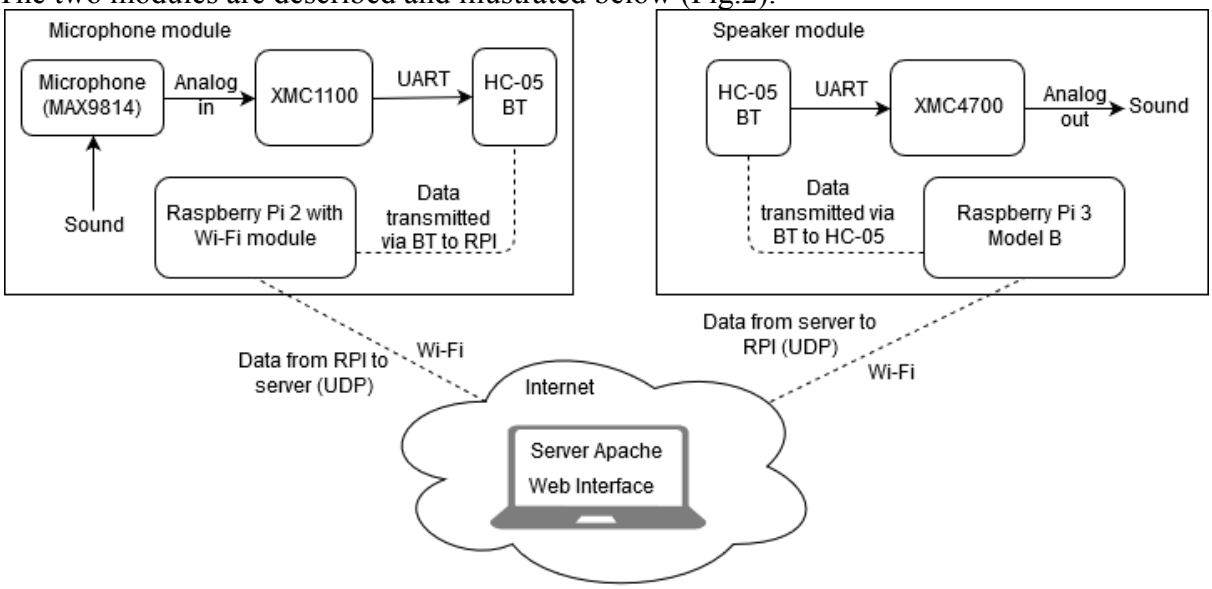

Fig.2 Module components and their interaction

The microphone module consists of the microphone (MAX 9814) which continuously picks up the sound around it and transmits it as analog data to the XMC1100. The data received by the XMC1100 goes into the ADC module for conversion into digital signal. An interrupt is called at the end of the conversion to mark the fact that there is a new set of data ready to be further transmitted. This set is sent via UART to the HC-05 BT module which sends it further to the RPI via BT. The RPI collects the data in sets of 1024 values and transmits it by using the UDP protocol via Wi-Fi to the server.

An Apache server was introduced between the two main modules. It receives the data from the RPI2 (microphone module) and afterwards it redirects it to the RPI3 (speaker module). The server was introduced in order to achieve a greater flexibility and scalability. More speaker modules can be introduced and data can be sent simultaneously to multiple end devices. The server also has a Web Interface (through a WebPage) which aims at making the product easier to use.

The RPI3 in the speaker module waits for sets of 1024 values from the server by listening at the designated port. It afterwards sends each of these sets via BT to the HC-05 module. The BT module sends the received data via UART to the XMC4700 where it is stored in a circular queue. On the XMC4700 a timer with a corresponding interrupt is used. The frequency of its activation is of 8KHz. On every interrupt call, two 8-bit values are taken from the buffer and composed into a 12-bit value. The latter is fed to the special DAC register and the DAC conversion starts. As a result there are the analog out values that the end-user can listen to.

Other specifications:

- The HC-05 BT module is set with a Baud Rate of 921600.
- The RPIs are configured as follows: console0 must be disabled as it is used by the OS for showing error messages etc and it does not allow continuous data transfer for other applications employing BT/UART. Afterwards one needs to manually activate uart0/ttyAMA0 by modifying /boot/config/txt.
- The RPIs must be configured to connect to the desired Wi-Fi network (by modifying /etc/wpa_supplicant/wpa_supplicant.conf).
- The Web Page on the server is hosted at localhost/index.html and it also contain CSS elements.

Further possible improvements:

- Sound processing options (by using different filters and Fourier transforms).
- Minimising existing delays.

6. Results presentation, demonstrative sequence

As obtained results, the sound picked up by the microphone from the first user was heard by the end-user with a small delay (approximately 5s). However, the sound was distorted and accompanied by noise. As next steps for improving the project, noise removal and further filtering of the sound will be addressed. This could be done on one of the RPIs.
In order to test the application, one simply needs to power up the microphone module, the server and the speaker module. Then the first user can speak near the microphone module and the end-user waits to hear the sound given by the speaker module. If the two modules are near by it is recommended to use rather headphones in order to avoid undesired effects. Also, the used microphone can easily pick up surrounding sounds so one does not need to talk right next to it.
Pictures were taken at the class project presentation during the lab hours.

7. Bibliography

- https://www.adafruit.com/product/1713
- https://www.raspberrypi.org/