# 2025年臺灣國際科學展覽會
# 優勝作品專輯

作品編號　190031

參展科別　電腦科學與資訊工程

作品名稱　Wibrazz

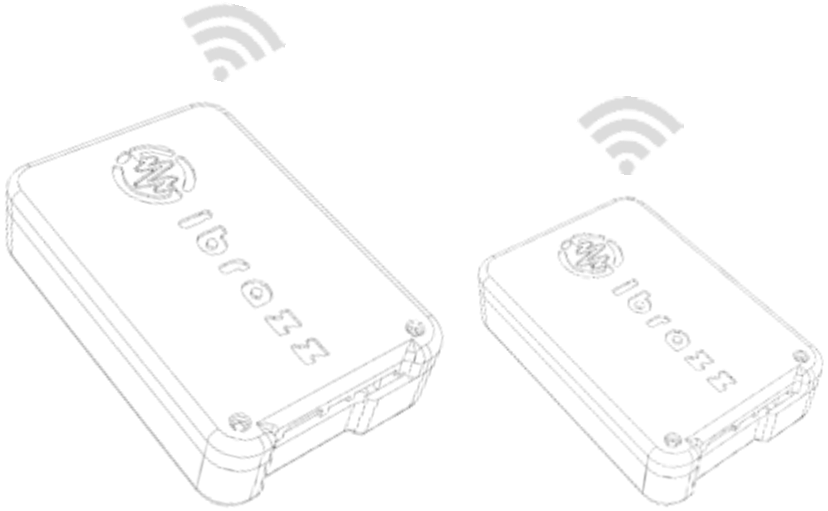
得獎獎項　三等獎

就讀學校　Nyíregyházi Vasvári Pál High School
指導教師　Gabor Laszlo Ivanka
作者姓名　Dalma Kamilla Zsigo

# 作者照片

# Wibrazz

*„Please accept me as*
*As I am*
*And then I will get better."*
András Simon



Dalma Kamilla Zsigó – Vasvári Pál High School in Nyíregyháza
Márton Simon - BMSZC Ottó Titusz Bláthy Information Technology Technical School
Taiwan International Science Fair
2024.

> Wibrazz is a wearable communication tool that allows the teacher, the therapist, the parent to communicate information to the child remotely using the device. Haptic (vibration-based) feedback is becoming increasingly important in everyday life. A vibrating device that transmits information through clothing can help people with disabilities who have no or limited sensory use to live an integrated life in society without barriers.

# History

Last year, the development team's goal was to create a device that would help make sports for the hearing impaired more accessible. The haptic feedback (vibration) proved to be a good idea, as it was successfully presented at the 32nd OTIO and won an award at the Taiwan International Science Fair! The device used a mesh network, which had many limitations, so we set out to develop a device based on a new principle. We also extended our original goal - to make sports for the hearing impaired accessible.

# Research

## *Interview with hearing impaired families*

Interviews with parents of hearing impaired children clearly show that a device that works in this way can be of great help in everyday life. Parents say that they can go to the playground, go hiking with a small group of children or even go to the playground with their hearing aids because they can send a message to their children in the form of vibrations. They also mentioned that it would help communication within the home, as it would be safe to send a message to a child living in the attic.

## *Interview with special needs teachers*

A preliminary questionnaire was sent to the teacher of children with hearing impairment. The answers of **Magda Bocskai** (Bárczi Gusztáv Primary School, Skills Development School, College and Unified Methodological Institute of Special Education in Nyíregyháza) confirmed and complemented our ideas. In their opinion, such a device would help the educational integration of hearing impaired children and they would be able to participate in leisure activities with more confidence! He helped us to contact **Tibor Pásku**, the director of the Hearing Impaired Children's Centre in Debrecen, and we can test the device in classroom conditions.

**Beáta Oroszné Terdik**, a special education teacher at the Pedagogical Specialist Service in Nagykálló, confirmed the possibilities of integrating the hearing impaired and gave us a brief outline of the areas in which she could use the device. She works with non-homogeneous groups, so the range of uses is quite broad. Helping to educate children with autism is a new area that has not been thought of before.

*„In my experience, the reason why it works well is that it sends signals directly to the skin. The skin is our largest sense organ, and in children this area works instinctively. We have an innate ability to feel touch, to feel cold, to feel warm. Even for severely handicapped children, these processes do not need to be taught separately. Signals sent to the skin are easily, quickly and well perceived, even by handicapped children. There are no obstacles to the flow of information. In the case of hearing impaired or visually impaired individuals, some signals from the outside world cannot be received. It is important for the receptors of an impaired person to find other ways to become active members of society. With the continuous use of Wibrazz, tactile and skin sensation can be developed." -* ***writes the teacher****.*

**Mária Tóth Nizsalóczkiné** *(Bárczy)* confirmed the views of her colleagues and added that she also considers this type of signalling system to be applicable to children with mild intellectual disabilities.

## *Possible uses of Wibrazz in development lessons:*

- Attention, at the beginning of a task.
- Maintaining attention, monitoring.
- It can be used as a basic tool for tactile development tasks, tactile training.
- In a group work it helps individual differantiation and individual guidance.
- A good opportunity to do additional tasks while performing the task.
- For children with hearing difficulties, it facilitates communication and makes the task easier to understand and perform.
- For children with visual impairment, it helps to guide the children.
- For children with autism, it helps communication, especially in the non-speaking group. In my experience, it also helps children who are over-sensitive to accept weak cues and helps to strengthen attentional processes.
- If I am working with more children and the group is a bit louder, I can help the children with vibration cues without sound and without instructions.

## Patent research - case studies

According to publicly available sources, there is no such toolkit commercially available. Study by Charbel Houinato for a previous (2017) industrial design competition at Thomas Jefferson University (USA). In it, she looks for a solution to the communication problems of hearing impaired athletes, and a version is being produced (Gallaudet University - Washington D.C. - is a deaf-friendly university whose hearing impaired basketball team uses non-verbal communication between themselves).

Vibration-based signalling systems have been widely used in some areas of life. Examples include vibrating order indicators in restaurants and wireless doorbells.

## Design

In this phase, the aim was to create an MVP model. Industrial design and electronics downsizing is the next step!

The following needs and criteria were formulated by analysing the results of the research:

- ✓ **Range:** minimum 200 metres outdoors
- ✓ **Waterproof encapsulation:** protection against sweat, accidental spillage
- ✓ **Use secure communication protocol:** ESP-NOW wireless protocol
- ✓ **Battery life:** at least 20 hours due to continuous use, ideally 1-2 days
- ✓ **Protection against damage:** preserving the integrity of electronics
- ✓ **Choice of material:** the material should be suitable to prevent injury to the wearer and to the companions
- ✓ **Suitable holder for attachment to the body:** attachment to the upper arm, possibly smartwatch like solution, attachment between tge shoulder blades - sports bra

## Solution

Two types of tools were created, one for parents/teachers/coaches/leaders (central tool) and one for children, students, athletes (play tool).

Parents/teachers/coaches can use their own (central) device to preset the buttons to signal to students/children over a radius of more than 200 metres. The devices communicate with each other using a special protocol (ESP-NOW). This allows them to be used for days on a single charge, and also ensures that phones, WiFi and other radio devices do not interfere with communication.

A phone and computer application has been developed to provide a range of functions. It is possible to use a mobile phone to control devices as a remote control, which is particularly useful for larger groups. It is possible to send a signal to each device, group or even the whole team individually.

Updating your device to a newer version via WiFi takes less than 15 seconds.

## Structure of the device

The circuit was created with EasyEda Pro, designed around the JLCPCB parts library, mainly with SMD parts. The device uses an ESP32 microcontroller and has a high gain antenna. The battery (700 mAh, li-po) can be charged with a USB-C cable. The power supply is provided by an LDO regulator, since the efficiency of a switch mode regulator would be lower in our case. The vibration motor is switched by a MOSFET.

*Figure 12.: The circuit under design (see: Annex 3)*
*Figure 13.: 3D model of the circuit (see: Annex 3)*
*Figure 14.,Figure 15.: The finished circuit (see: Annex 3)*

The circuit is fixed to the case with an M2 screw and a silicone vibration damping ring. For the very first programming of the microcontroller, we need a UART-Serial converter and a spring-loaded connector. It can then be upgraded wirelessly. The hardware difference between the player and central device is that extra buttons have been added.

*Figure 16.: The tool used for the very first programming (see: Annex 3.)*

The custom boxes were created using Fusion360 and 3D printed. The player and central devices were given separate cases accordingly.

*Figure 18. - Figure 21.: Pictures of the 3D plans (see: Annex 3.)*
*Figure 22., Figure 23.: Picture of the printed boxes (see: Annex 3.)*
*Figure 1. - Figure 3.: Complited product (see: Annex 1.)*

The resulting application is a PWA (progressive web app) website, which allows it to be installed and run offline, i. e. it behaves like a traditional application. The development was done in Angular. The interface is available in both English and Hungarian, it is possible to connect to dvóevices via Bluetooth, personalise, update and use a phone for control instead of central unit.

*Figure 17.: Schematic diagram of communication (see: Annex 3.)*
*Figure 4. - Figure 11.: Application images (see: Annex 3.)*

The app is available: [wibrazz.web.app](wibrazz.web.app)

## Summary

The objectives set - to develop an appropriate toolkit - have been achieved.

We have put together toolkits

- **family**(1 central + 2 player)
- **classroom** (1 central + 8 player)
- **team sports** (2 central + 20 player)

The tools are being tested in two schools, in a therapy group.

Additional toolkits are being developed and will be sent to athletes and clubs for testing in the next round.

Special needs teachers have high hopes for the tool's applicability in schools. Helping children with these problems is a difficult task in today's world. There are more and more immature, damaged and special-needs minors. The number of therapeutic cases has doubled in the last decade.

## The future of the project

Our team entered the START PRO competition to support start-ups and was one of 16 teams mentored. The programme is run by Design Terminal experts and external experts. Our aim is to create a business that can thrive on the international market.

We would also like a design professional to join the team.

## Felhasznált irodalom


- Magdolna Bocskai - Éva Rádai Tóthné: Information booklet for teachers working in an integrated way with hearing impaired children and pupils Publication of the Bárczi Gusztáv Primary School, Skills Development Special Special School, College, Unified Special Pedagogical Methodological Institute of Nyíregyháza
- Anett Lovászi - Andrea Dúll: MEGÉRINT A LÁTVÁNY - https://communicatio.hu/jelkep/2014/1/lovaszi_anett_dull_andrea.htm
- How one NCAA basketball team plays the game using sign language https://www.npr.org/2024/03/31/1241888315/how-one-ncaa-basketball-team-plays-the-game-using-sign-language
- V Sports: An Even Ground for Deaf Athletes - https://jdc.jefferson.edu/cgi/viewcontent.cgi?article=1005&context=idcapstones&fbclid=IwAR2QRx3DWimc4lsx0nPOxk6RKq0Sm8eRH_bN4Vahlq6dRPc00JUnA4BxwuU


## Content

# Annex 1.: Pictures and videos of the finished product

Figure 1.: The devices in the on state

Figure 2.: During assembly, without lid

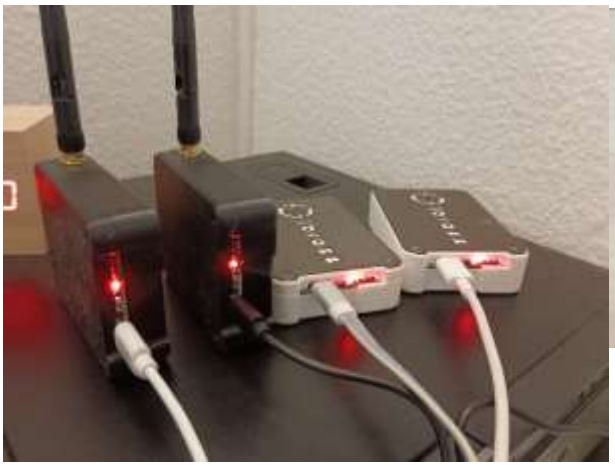


Figure 3.: During charging

Video: ctrl + left click on the image

# Annex 2.: Pictures of the app

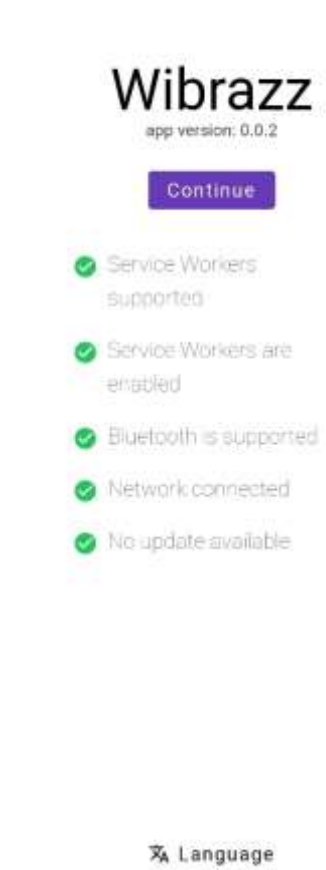



Figure 4: Home screen


Figure 5: During Bluetooth connection


Figure 6: Data of the device


Figure 7: the phone can be used as a remote control, where you can signal one by one a játékosoknak


Figure 8: Switching in case of team play

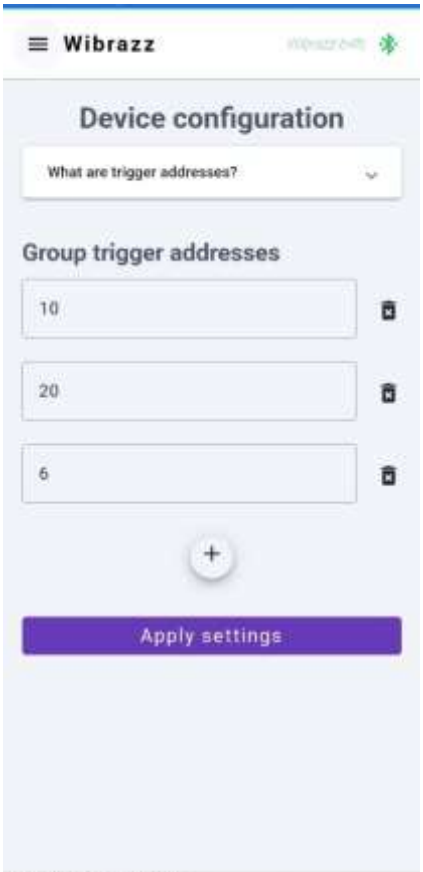



Figure 9: Device setup

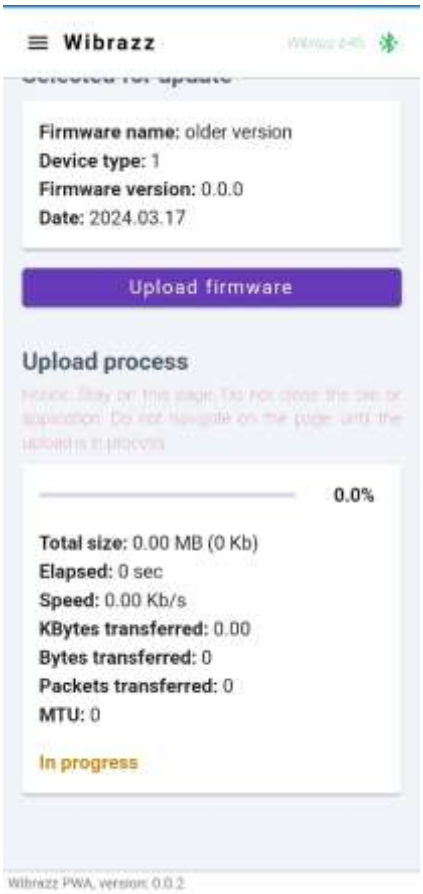



*Figure 10: Updating your device using the website*


*FIgure 11: Instructions for use in the event of blockage*

The PWA app is built using Angular, Angular Material and Tailwind CSS, so it can be used offline. For communication we use the WEB BLE API. It is currently hosted on Firebase.

# Annex 3.: Structure of the instrument

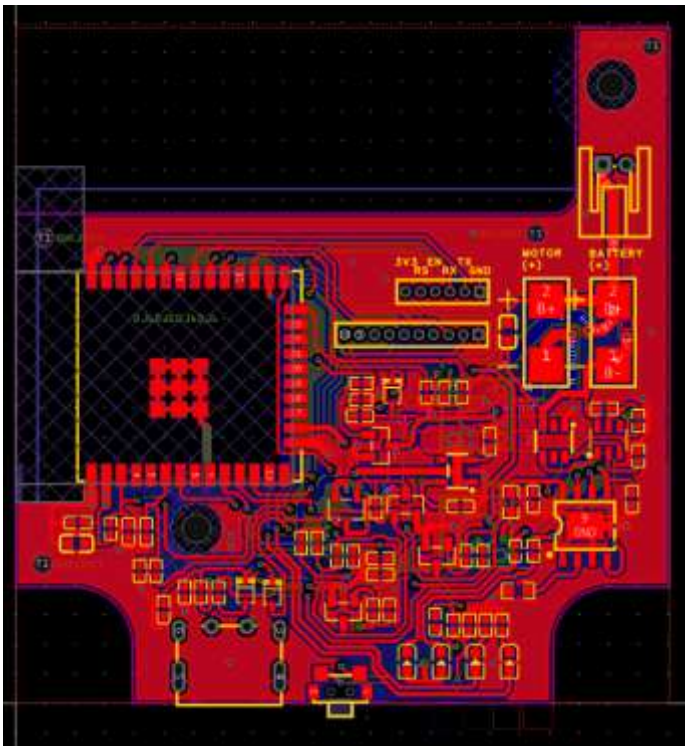


Figure 12: The circuit under design

Figure 13: 3D model of the circuit

Figure 14: The ordered circuits assembled with small components

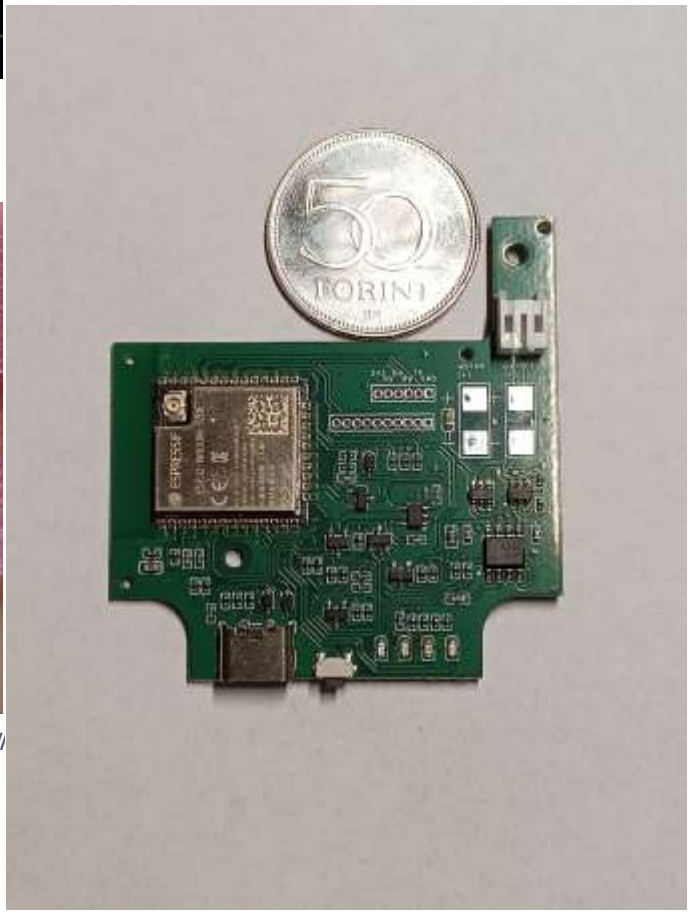


Figure 15: Close up of the circuit

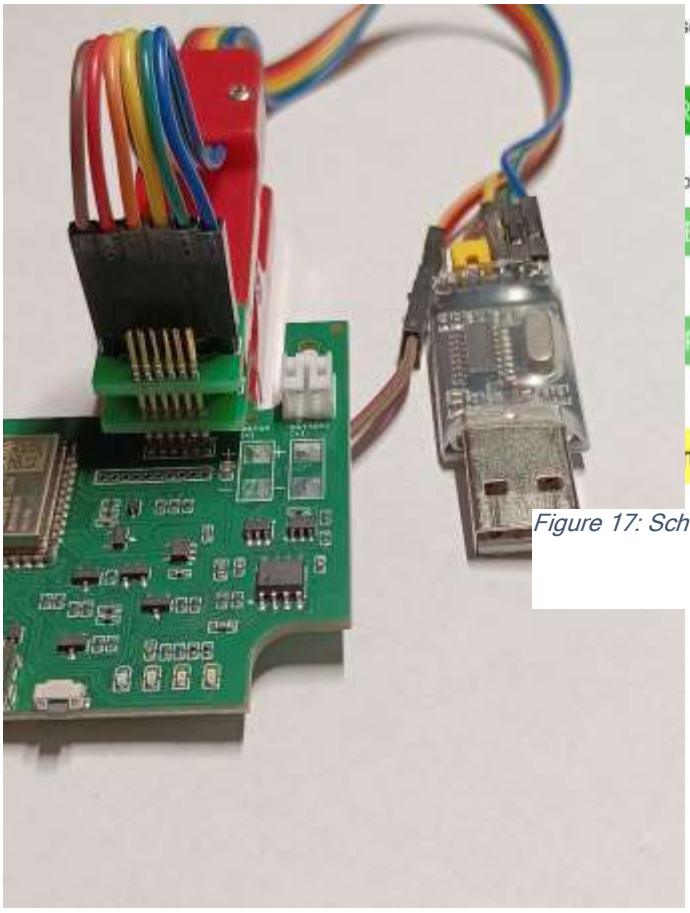


*Figure 16: The tool used for programming*

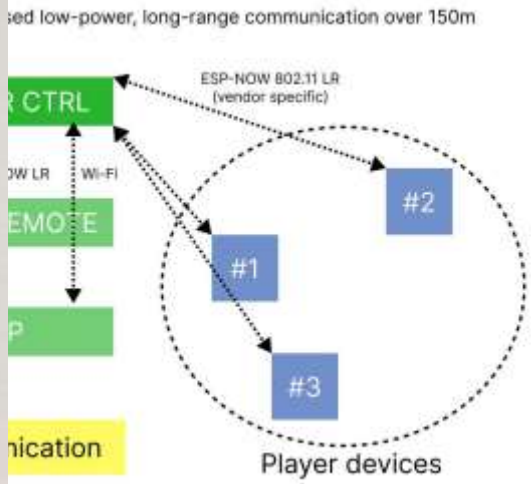



*Figure 17: Schematic diagram of the communication process*

*Figure 18: 3D plan of a player device*

*Figure 19: 3D design of a player device*

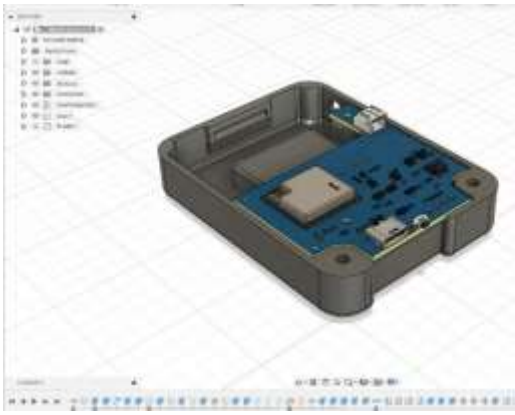


Figure 20: Central unit 3D plan

Figure 21: Central unit 3D plan

Figure 22: 3D printed player (left) and central (right) unit


Figure 23: 3D printed player (left) and central (right) unit

# Annex 4: Range

Range and extremely low power consumption were important, so we opted for ESP-NOW, which uses vendor-specific WiFi frames with a unique long-range protocol (2.4 GHz). The devices synchronise time intervals and, when this is done, go to sleep between two transmissions, significantly reducing power consumption.

To further increase the range, the central unit was equipped with a larger external antenna, which was also used for tests. When tested in an empty, unobstructed area, almost all packets were received at a distance of 135 m (98% reached their destination). If the central unit is placed higher, the signal can reach up to 400 m (Fresnel zone).

Indoors, through the walls, it worked perfectly during the tests.

# 【評語】190031

1. The proposed vibration-based communication system seems to have good use cases for hearing-impaired users and others.
2. It would be good to extend the vibration patterns and make use of them as a language (a word sequence) for effective communications and more diverse applications.
3. It is suggested to provide subjective and/or objective evaluations on the proposed systems to better showcase its efficacy.