THE SCENT OF IMMERSION: BRIDGING SMELL AND LEARNING IN VIRTUAL REALITY

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- **Virtual reality** (VR) is increasingly used in **education**, enhancing knowledge acquisition and engagement.
- The sense of **smell**, however, remains **underdeveloped** in VR despite its **strong connection to memory and emotion**.
- This project **integrates smell into VR** using a portable, wireless device via distance communication from the VR headset.

Introduction

- Virtual and augmented reality are **growing** in education, healthcare, training, and entertainment.
- **Significant realism** achieved through high-definition graphics, motion tracking [7], and haptic feedback [4].
- **Olfactory stimuli** can improve information **recall**, invoke **emotions**, and boost task **performance** in VR [1-3].

Motivation and objectives

- **Problem**: Lack of olfactory integration limits VR immersion.
- **Challenges of existing solutions**: Delayed activation, bulkiness, limited mobility [5,6].
- Our **motivation**: Address these issues by designing a lightweight, portable system for real-time smell integration.
- **Objective**: Develop a more immersive and accessible **olfactory VR experience for educational settings**.

System implementation

Circuit design (*Figure 1*) = 8 ultrasonic **atomizers** (scent dispersion) + **relays** (switches for activation) + **ESP32** microcontroller (control logic) + power bank (for powering).

The **final prototype** shown in *Figure 2* displays all the components in a compact **3D printed case** of own design.

For the **scent triggering**, the **distance** between the user's head and the scent objects is **tracked** by the VR headset and **communicated** to the ESP32 via **WebSocket**. The corresponding scent is released when the distance is below a **threshold**, which can be **configured** through a web interface. This communication is represented in *Figure 3*.

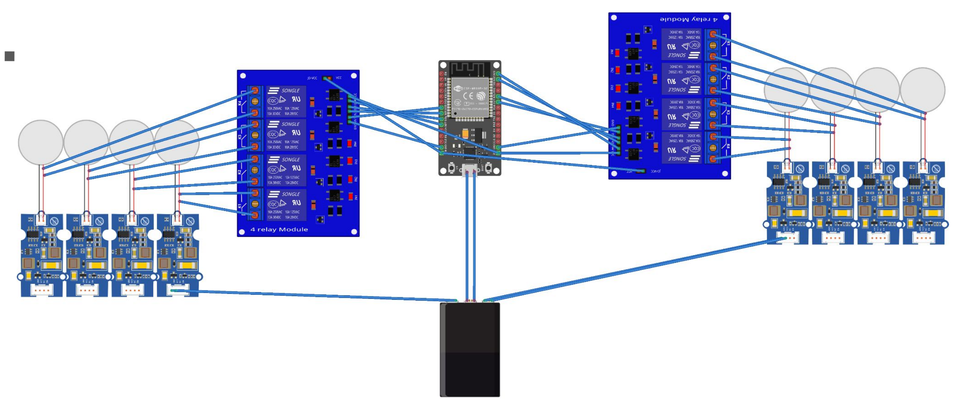

Figure 1. Circuit design

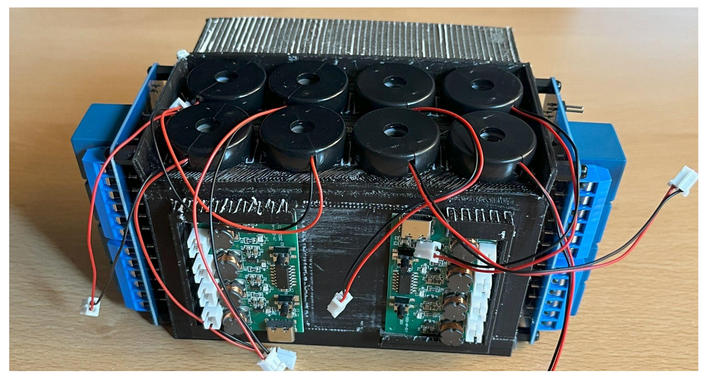

Figure 2. Final prototype

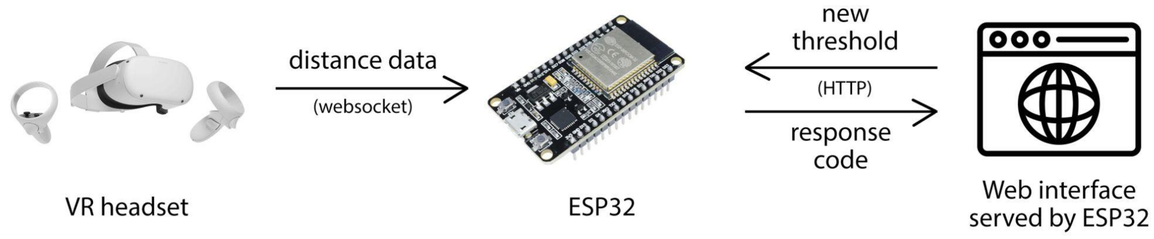

Figure 3. Communication diagram [8-10]

User evaluation

- **Goal**: Confirm scent **perception**, verify **synchronization**, assess **threshold impact**, identify **improvements**.
- **Results**: Overall **positive**, scents perceived, original experience and **enjoyable**. Minor initial delays before threshold customization, **device weight**, clicking sound.

Conclusions

- **Feasibility proven** for integrating smell into VR with a portable, responsive system,
- **Future work**: Improve scent delivery, conduct **studies** on impact on learning, memory and engagement.

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