

ESP32S3 TTS DEMO

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- 成果展示

代码仓库

Github (国外) <https://github.com/pai2shub/esp32-tts>

CNB (国内) <https://cnb.cool/rzhangsan/hoh/esp32-tts>

AI 文档

Deepwiki <https://deepwiki.com/pai2shub/esp32-tts>

Zread (中文) <https://zread.ai/pai2shub/esp32-tts>

项目概要及相关硬件

ESP32-S3 芯片上实现完整的 TTS （中文） Demo

- 创建 WiFi AP，托管 Web 服务器，用户通过 Web 浏览器提交文本进行语音合成及音量控制
- 合成的音频通过 I2S 连接的扬声器输出，系统状态、文本则显示在 LVGL UI 的 LCD 屏幕上
- 支持通过按钮、Web 页面调节音量

- 框架：ESP-IDF（乐鑫物联网开发框架），用于硬件抽象和系统服务
- TTS 引擎：ESP-SR（乐鑫语音识别）框架，用于中文文本转语音转换
- 显示：LVGL（轻量级多功能图形库），用于创建响应式用户界面
- 网络：Wifi AP + 嵌入式 HTTP 服务器，支持 RESTful API
- 音频：I2S 数字音频接口，用于高质量声音输出
- 核心：FFI



Rust 工具链

```
rust-toolchain.toml 1 X
rust-toolchain.toml > ...
1 [toolchain]
2 channel = "esp"
3
```

```
• → /workspace git:(master) rustup run esp rustc --version
rustc 1.88.0-nightly (2ab28d2e7 2025-06-24) (1.88.0.0)
• → /workspace git:(master) rustup run stable-x86_64-unknown-linux-gnu rustc --version
rustc 1.89.0 (29483883e 2025-08-04)
○ → /workspace git:(master)
```

esp 用 rust 安装的 rust

```
• → /workspace git:(master) rustup show
Default host: x86_64-unknown-linux-gnu
rustup home: /root/.rustup

installed toolchains
-----
stable-x86_64-unknown-linux-gnu (default)
esp (active)

active toolchain
-----
name: esp
active because: overridden by '/workspace/rust-toolchain.toml'
installed targets:
○ → /workspace git:(master)
```

代码统计

src

audio.rs
button.rs
global.rs
main.rs
server.rs
tts.rs
ui_lvgl.rs
utils.rs
wifi.rs

```
→ /workspace git:(master) tokei src/
```

Language	Files	Lines	Code	Comments	Blanks
Rust	9	813	632	48	133
- Markdown	1	14	0	11	3
(Total)		827	632	59	136
Total	9	813	632	48	133

```
→ /workspace git:(master)
```

```
→ /workspace git:(master) tokei
```

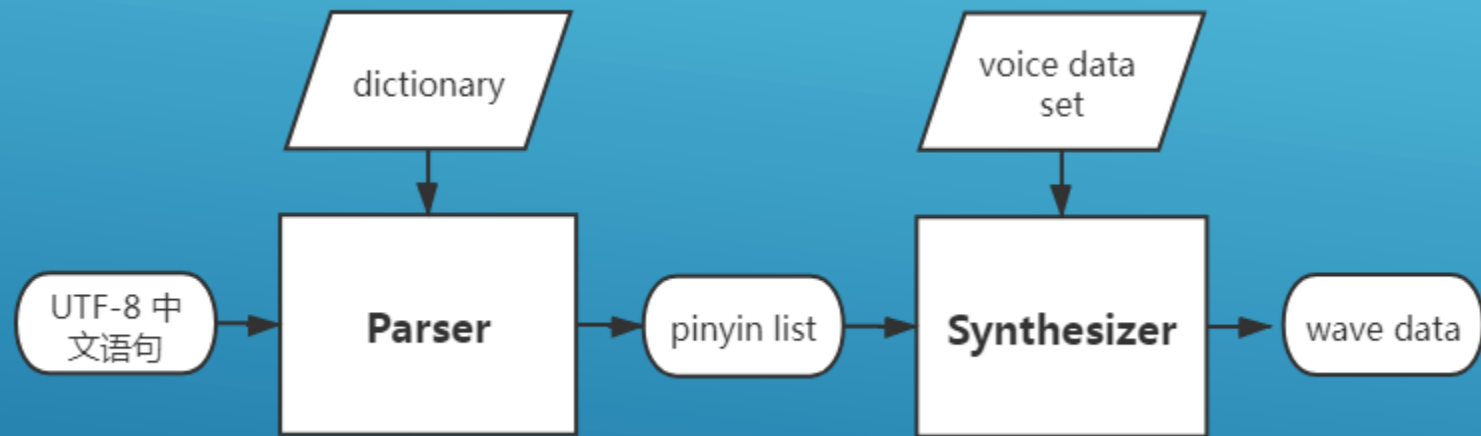
Language	Files	Lines	Code	Comments	Blanks
Batch	1	23	17	0	6
C	1	105318	63272	21022	21024
C Header	4	1164	536	389	239
JSON	1	34	34	0	0
Shell	5	44	23	6	15
TOML	4	92	54	15	23
HTML	1	48	41	0	7
- CSS	1	13	13	0	0
- JavaScript	1	120	108	3	9
(Total)		181	162	3	16
Markdown	1	49	0	33	16
- TOML	1	4	4	0	0
(Total)		53	4	33	16
Rust	10	1025	824	51	150
- Markdown	1	14	0	11	3
(Total)		1039	824	62	153
Total	28	107797	64801	21516	21480

```
→ /workspace git:(master)
```

components

> esp_sr
> lvgl-configs
> lvgl-custom-fonts

乐鑫 TTS



乐鑫 TTS - Rust

```
impl TTS {
    pub fn new() -> Self {
        log::error!("couldn't map voice data partition!");
        return;
    }
    log::info!("esp partition mmap initialized");

    let voicedata_mut: *mut c_void = voicedata as *mut std::ffi::c_void;
    let voice = esp_sr::esp_tts_voice_set_init(
        &esp_sr::esp_tts_voice_template as *const _,
        voicedata_mut,
    );
    log::info!("esp_tts_voice_set_init");

    tts_handle = esp_sr::esp_tts_create(voice);
    log::info!("esp_tts_create");
}
```

乐鑫 TTS - Rust

```
impl TTS {
    pub fn play(self, data: String, tx: mpsc::Sender<&[u8]>) {

        if esp_sr::esp_tts_parse_chinese(tts_handle, prompt.as_ptr()) == 0 {
            log::error!("esp_tts_parse_chinese fail");
        }

        let mut len: [i32; _] = [0i32; 1];
        loop {
            let pcm_data: *const u8 = esp_sr::esp_tts_stream_play(tts_handle, len.as_mut_ptr(), 3);
            if len[0] <= 0 {
                break;
            }

            // play sound
            let pcm_slice: &[u8] = slice::from_raw_parts(
                pcm_data as *const u8, // 转为字节指针
                (len[0] * 2) as usize, // 总字节数
            );

            tx.send(pcm_slice);
        }
    }
} fn play
```


LVGL- Rust

https://github.com/enelson1001/lv_binding_rust

```
ui_lvgl.rs X
src > ui_lvgl.rs > {} impl UI > run
 95  impl UI {
105      pub fn run(&mut self, rx: mpsc::Receiver<String>) {
107          const HOR_RES: u32 = constant::DISPLAY_WIDTH as u32;
108          const VER_RES: u32 = constant::DISPLAY_HEIGHT as u32;
109          const LINES: u32 = 4; // The number of lines (rows) that will be refreshed
                                   was 12
110          let draw_buffer: DrawBuffer<_> = DrawBuffer::<N: { (HOR_RES * LINES) as
                                   usize }>::default();
111          let display: Display = Display::register(draw_buffer, HOR_RES, VER_RES,
                                   display_update: |refresh: &DisplayRefresh<_...| {
112              Self::set_pixels_lvgl_color(
113                  sx: refresh.area.x1.into(),
114                  sy: refresh.area.y1.into(),
115                  ex: (refresh.area.x2 + 1i16).into(),
116                  ey: (refresh.area.y2 + 1i16).into(),
117                  colors: refresh.colors.into_iter(),
118              ) Result<(), EspError>
119                  .unwrap();
120          }) Result<Display, DisplayError>
```

编译

代码视图

Blame

```
1 #!/bin/bash
2 set -e
3
4 . /root/export-esp.sh
5
6 cargo build --release
7
8 source setup-idf.sh
9
10 chmod +x merged.sh
11
12 ./merged.sh
13
14 # rm -rf merged.sh
15
```

```
→ /workspace git:(master) ./build.sh
= note: `[warn(dead_code)]` on by default
help: consider changing the field to be of unit type to suppress this warning
|
21 -     AnyEdge(ButtonType),
21 +     AnyEdge(()),
|

warning: `etts` (bin "etts") generated 2 warnings (run `cargo fix --bin "etts" --` to fix)
Finished `release` profile [optimized] target(s) in 2m 17s
WARNING: using an unsupported version of tool xtensa-esp-elf found in PATH: 3.25.1
WARNING: using an unsupported version of tool cmake found in PATH: 3.25.1
WARNING: using an unsupported version of tool ninja found in PATH: 1.11.1
export ESP_ROM_ELF_DIR="/.embuild/espressif/tools/esp-rom-elfs/20241011/"
port IDF_DEACTIVATE_FILE_PATH="/tmp/tmpgrtvnbehidf_3821"
Checking "python3" ...
Python 3.11.2
"python3" has been detected
Activating ESP-IDF 5.4
Setting IDF_PATH to '/.embuild/espressif/esp-idf/v5.4.1'.
* Checking python version ... 3.11.2
* Checking python dependencies ... OK
* Deactivating the current ESP-IDF environment (if any) ... OK
* Establishing a new ESP-IDF environment ... OK
* Identifying shell ... bash
* Detecting outdated tools in system ... OK - no outdated tools found
* Shell completion ... Autocompletion code generated
█
```

```
→ /workspace git:(master) ./build.sh
```

```
parse partitions_map result:
key: voice_data, value: 0x710000
key: phy_init, value: 0x209000
key: factory, value: 0x210000
key: nvs, value: 0x9000
```

```
=== esptool.py merge_bin ===
esptool.py v4.10.0
Wrote 0x98b670 bytes to file merged.bin, ready to flash to offset 0x0
```

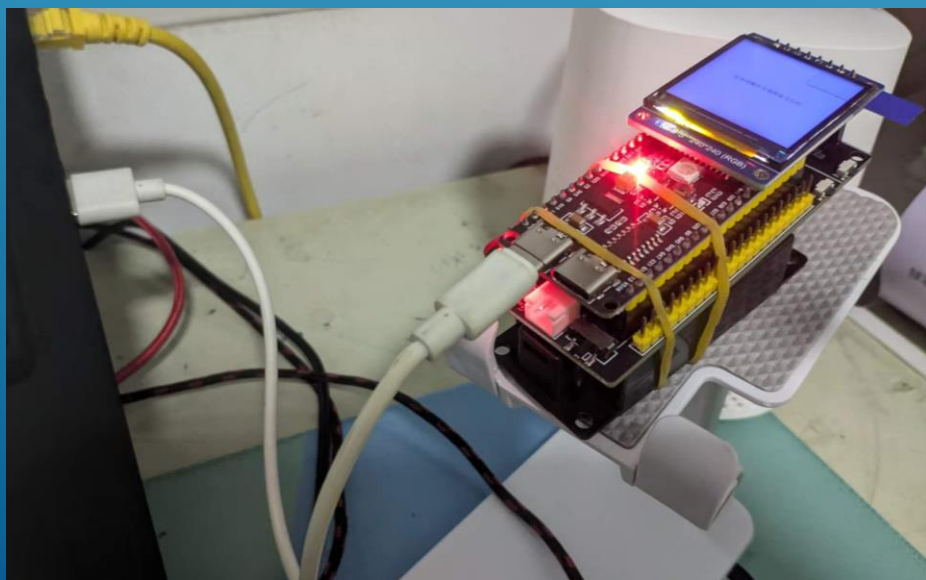
```
=== esptool.py image_info merged.bin ===
esptool.py v4.10.0
File size: 10008176 (bytes)
Detected image type: ESP32-S3
Image version: 1
Entry point: 403c8928
4 segments
```

```
Segment 1: len 0x015a0 load 0x3fce2810 file_offs 0x00000018 [BYTE_ACCESSIBLE, MEM_INTERNAL, DRAM]
Segment 2: len 0x00004 load 0x403c8700 file_offs 0x000015c0 [MEM_INTERNAL, IRAM]
Segment 3: len 0x00d20 load 0x403c8704 file_offs 0x000015cc [MEM_INTERNAL, IRAM]
Segment 4: len 0x02f00 load 0x403cb700 file_offs 0x000022f4 [MEM_INTERNAL, IRAM]
Checksum: 60 (valid)
Validation Hash: 3c3de98461193ed686fc6f8870c875581c7a1446881904e0b67f5f84e1ba85dd (valid)
```

```
→ /workspace git:(master)
```

本地烧录

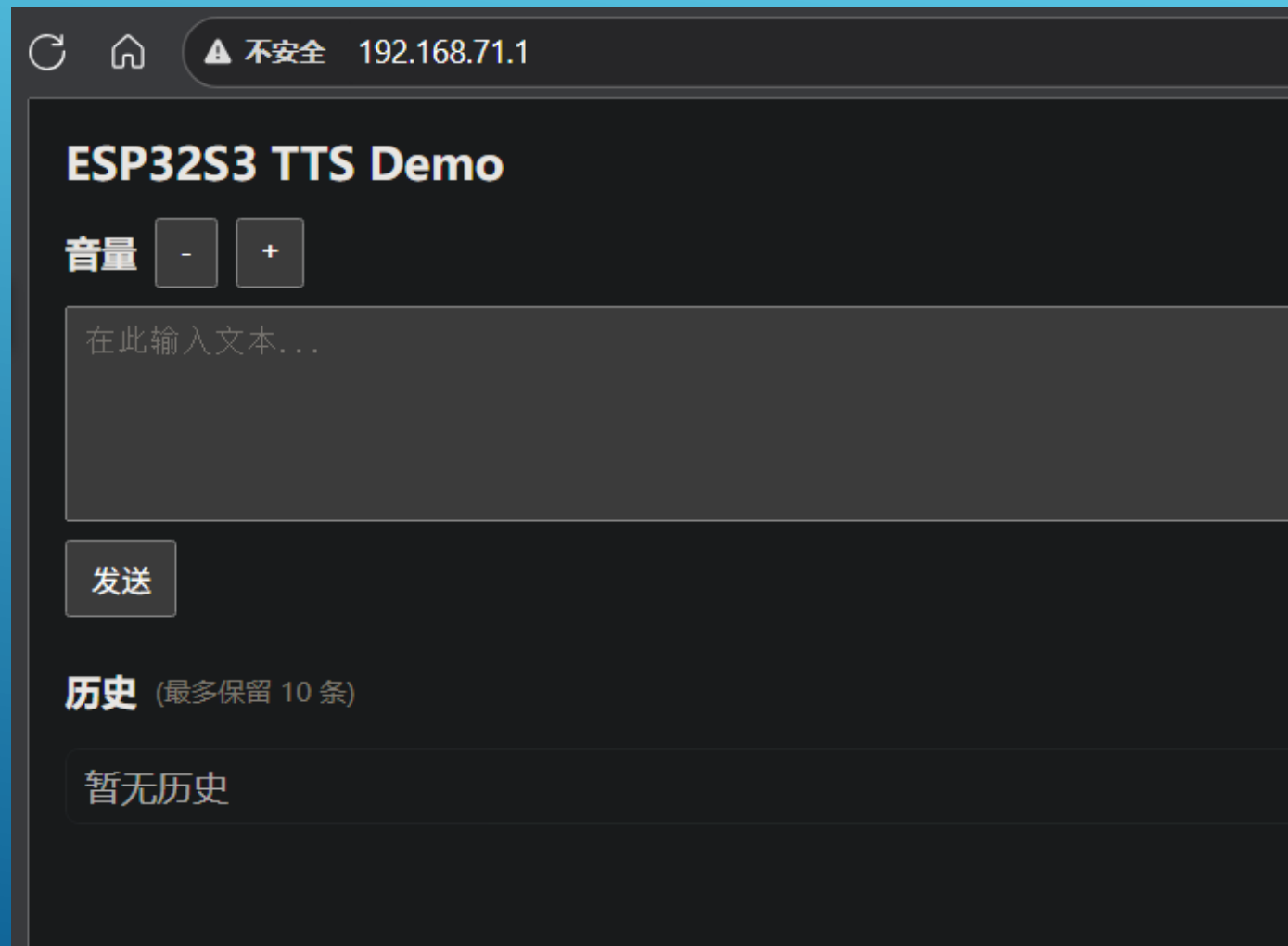
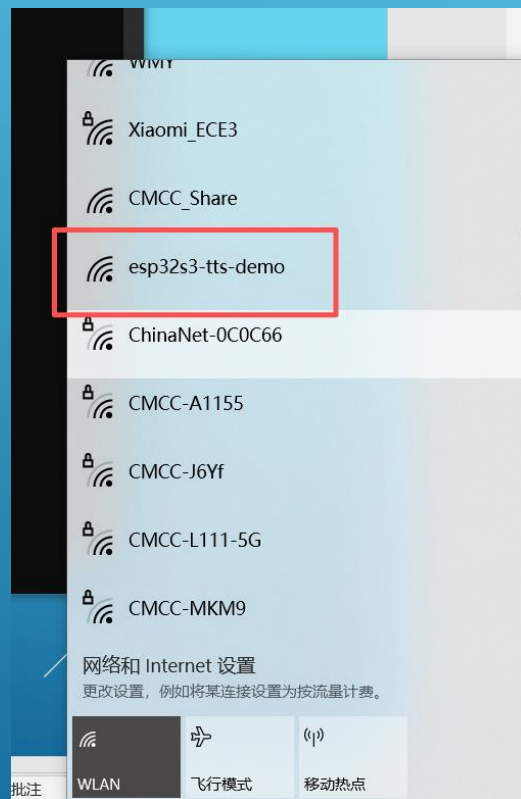
```
PS E:\> espflash write-bin --monitor 0x000000 merged.bin
[2025-09-23T11:13:27Z INFO ] 🚀 A new version of espflash is available: v4.1.0
[2025-09-23T11:13:27Z INFO ] Serial port: 'COM10'
[2025-09-23T11:13:27Z INFO ] Connecting...
[2025-09-23T11:13:27Z INFO ] Using flash stub
Chip type:      esp32s3 (revision v0.2)
Crystal frequency: 40 MHz
Flash size:     16MB
Features:       WiFi, BLE, Embedded Flash
MAC address:    98:a3:16:f1:9e:5c
```



播放示例文字

```
Windows PowerShell
I (1559) etts::wifi: Waiting for DHCP lease...
I (1563) etts::wifi: Wifi AP MAC: Ok([152, 163, 22, 241, 158, 92])
I (1568) etts::wifi: Wifi IP info: IpInfo { ip: 192.168.71.1, subnet: Subnet { gateway: 192.168.71.1, mask: Mask(24) },
dns: Some(8.8.8.8), secondary_dns: Some(8.8.8.8) }
I (1583) etts: Wifi AP SSID: "esp32s3-tts-demo"
I (1588) etts: Wifi AP IP: IpInfo { ip: 192.168.71.1, subnet: Subnet { gateway: 192.168.71.1, mask: Mask(24) }, dns: Som
e(8.8.8.8), secondary_dns: Some(8.8.8.8) }
I (1602) etts::utils: Free SPIRAM heap size: 8372468
I (1606) etts::utils: Free INTERNAL heap size: 124587
I (1612) etts: wait_for_any_edge btn_k0
I (1615) etts::tts: prompt: 欢迎使用文字转转语音示例
I (1620) tts_parser: unicode:0x6b22 -> huan1
I (1625) tts_parser: unicode:0x8fce -> ying2
I (1630) tts_parser: unicode:0x4f7f -> shi3
I (1635) tts_parser: unicode:0x7528 -> yong4
I (1640) tts_parser: unicode:0x6587 -> wen2
I (1645) tts_parser: unicode:0x5b57 -> zi4
I (1650) tts_parser: unicode:0x8f6c -> zhuan3
I (1655) tts_parser: unicode:0x8f6c -> zhuan3
I (1660) tts_parser: unicode:0x8bed -> yu3
I (1665) tts_parser: unicode:0x97f3 -> yin1
I (1669) tts_parser: unicode:0x793a -> shi4
I (1674) tts_parser: unicode:0x4f8b -> li4
I (11238) etts: wait_for_any_edge AnyEdge(K0)
I (11238) etts: start server
I (11238) etts::server: starting server
I (11241) esp_idf_svc::http::server: Started Httpd server with config Configuration { http_port: 80, ctrl_port: 32768, h
ttps_port: 443, max_sessions: 16, session_timeout: 1200s, stack_size: 10240, max_open_sockets: 4, max_uri_handlers: 32,
max_resp_headers: 8, lru_purge_enable: true, uri_match_wildcard: false }
I (11265) esp_idf_svc::http::server: Registered Httpd server handler Get for URI "/"
```

Wifi AP 连接控制



Wifi AP 连接控制

ESP32S3 TTS Demo

音量 正在设置...

在此输入文本...

发送

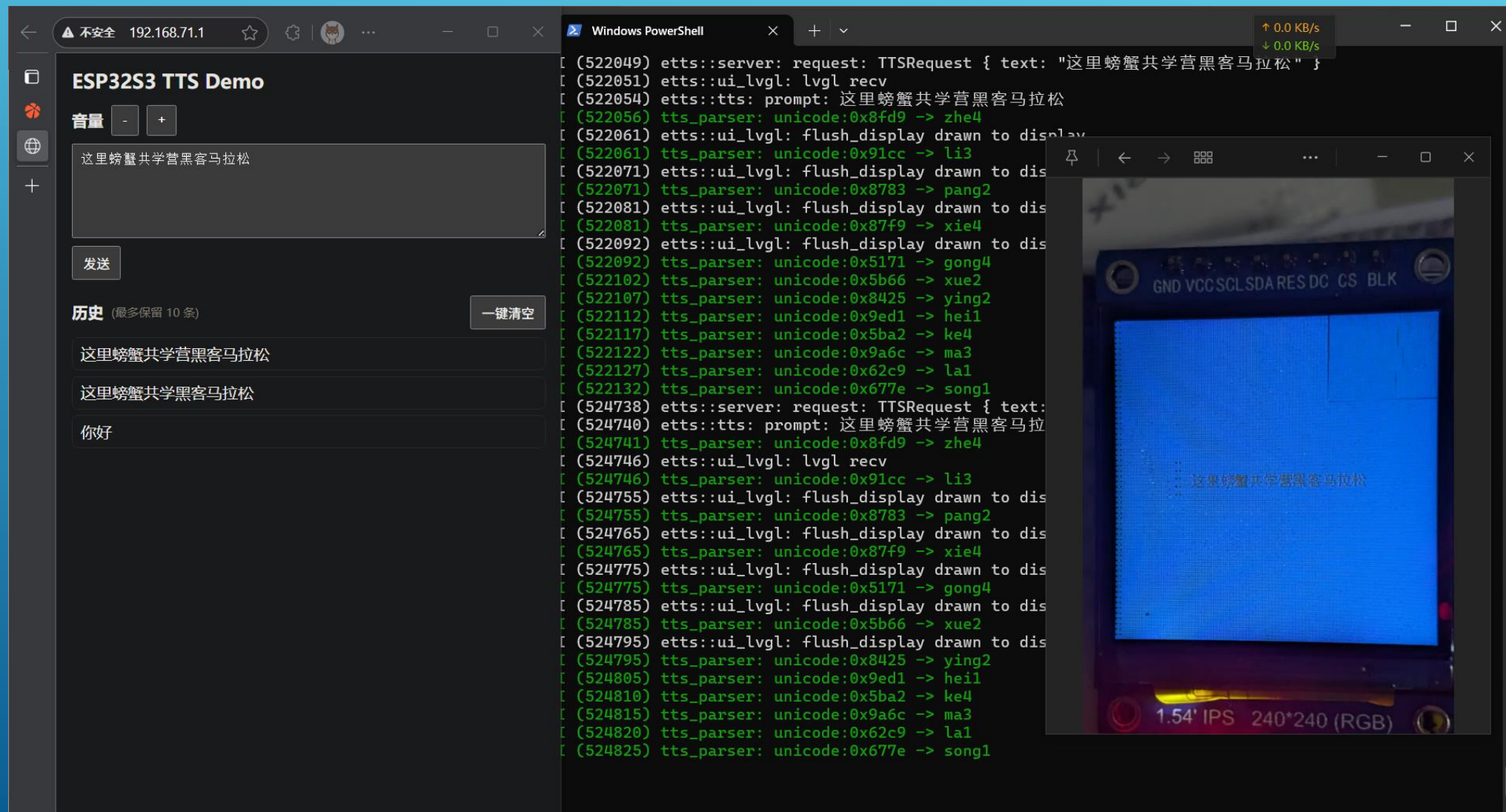
历史 (最多保留 10 条)

一键清空

暂无历史

```
I (381982) etts::server: request: VolumeRequest { op: "inc" }
I (381982) etts::audio: volume_up
I (382543) etts::server: request: VolumeRequest { op: "inc" }
I (382543) etts::audio: volume_up ↑ 2.2 KB/s
I (382919) etts::server: request: VolumeRequest { op: "inc" } ↓ 0.4 KB/s
I (382920) etts::audio: volume_up
I (383197) etts::server: request: VolumeRequest { op: "inc" }
I (383198) etts::audio: volume_up
I (383398) etts::server: request: VolumeRequest { op: "inc" }
I (383398) etts::audio: volume_up
I (383592) etts::server: request: VolumeRequest { op: "inc" }
I (383592) etts::audio: volume_up
I (383790) etts::server: request: VolumeRequest { op: "inc" }
I (383790) etts::audio: volume_up
I (383982) etts::server: request: VolumeRequest { op: "inc" }
I (383982) etts::audio: volume_up
I (384176) etts::server: request: VolumeRequest { op: "inc" }
I (384176) etts::audio: volume_up
I (384366) etts::server: request: VolumeRequest { op: "inc" }
I (384366) etts::audio: volume_up
I (384558) etts::server: request: VolumeRequest { op: "inc" }
I (384558) etts::audio: volume_up
I (384742) etts::server: request: VolumeRequest { op: "inc" }
I (384743) etts::audio: volume_up
I (384935) etts::server: request: VolumeRequest { op: "inc" }
I (384935) etts::audio: volume_up
I (385126) etts::server: request: VolumeRequest { op: "inc" }
I (385127) etts::audio: volume_up
I (385333) etts::server: request: VolumeRequest { op: "inc" }
I (385334) etts::audio: volume_up
I (385520) etts::server: request: VolumeRequest { op: "inc" }
I (385521) etts::audio: volume_up
I (385709) etts::server: request: VolumeRequest { op: "inc" }
I (385710) etts::audio: volume_up
I (385902) etts::server: request: VolumeRequest { op: "inc" }
I (385902) etts::audio: volume_up
I (386094) etts::server: request: VolumeRequest { op: "inc" }
I (386094) etts::audio: volume_up
I (386285) etts::server: request: VolumeRequest { op: "inc" }
I (386285) etts::audio: volume_up
I
```


语音播放



Ref

- 乐鑫 esp32s3 文档 https://docs.espressif.com/projects/esp-idf/zh_CN/stable/esp32s3/get-started/index.html
- 乐鑫 sr 文档 https://docs.espressif.com/projects/esp-sr/zh_CN/latest/esp32s3/getting_started/readme.html
- 《The Rust on ESP Book》

<https://docs.espressif.com/projects/rust/book/tooling/debugging/probe-rs.html>

THANKS

