Hardware Setup Guide - Voice Cloakroom System

Quick Assembly Instructions for Hardware Hackathon

Required Components

- [ ] AtomS3R AI Chatbot Kit (Voice processor)
- [ ] ESP32-S3 Reverse TFT Feather (Display controller)
- [ ] IS31FL3741 RGB LED Matrix Driver
- [ ] Mini I2C Gamepad with seesaw
- [ ] QT Slide Potentiometer with 4 NeoPixels
- [ ] LSM6DSOX Accelerometer/Gyroscope
- [ ] I2C/STEMMA QT cables (50mm and 100mm)
- [ ] USB-C cables for programming and power

System Architecture

```
[AtomS3R] ←→ I2C ←→ [ESP32-S3 Feather] ←→ I2C Bus ←→ [Sensors/Controls]
   ↓              ↓                    ↓
Voice Processing  TFT Display          LED Matrix, Gamepad,
ElevenLabs API    User Interface       Slider, Accelerometer
```

Wiring Connections

I2C Bus Configuration

Primary I2C Bus (100kHz)

- SDA: GPIO 3 (ESP32-S3 Feather)
- SCL: GPIO 4 (ESP32-S3 Feather)
- Pull-up resistors: Built into STEMMA QT connectors

AtomS3R Connections

```
AtomS3R → ESP32-S3 Feather
- I2C SDA → GPIO 3 (via STEMMA cable)
- I2C SCL → GPIO 4 (via STEMMA cable)
- GND → GND
- 3.3V → 3.3V
```

ESP32-S3 Feather Pin Assignments

```
GPIO 3  → I2C SDA (STEMMA QT connector)
GPIO 4  → I2C SCL (STEMMA QT connector)
GPIO 7  → TFT CS
GPIO 39 → TFT DC
GPIO 40 → TFT RST
GPIO 45 → TFT Backlight
```

I2C Device Addresses

```
AtomS3R:          0x42 (I2C slave mode)
Gamepad (seesaw):  0x50
Slider (seesaw):   0x30
LED Matrix:       0x30 (alternative address)
Accelerometer:     0x6A (default LSM6DS address)
```

Assembly Steps

Step 1: Power Connections

1. Connect USB-C cable to ESP32-S3 Feather for power and programming
2. Connect USB-C cable to AtomS3R for power and programming
3. Verify both devices power on (LED indicators should activate)

Step 2: I2C Bus Setup

1. Connect STEMMA QT cable from ESP32-S3 Feather to AtomS3R
2. Use STEMMA QT hub or daisy-chain additional sensors:

```
ESP32-S3 → Gamepad → Slider → LED Matrix → Accelerometer
```

3. Ensure all connections are secure and cables are not strained

Step 3: Display Verification

1. Upload test firmware to ESP32-S3 Feather
2. Verify TFT display shows initialization screen
3. Check LED matrix displays test pattern

4. Confirm gamepad buttons register input

Step 4: Voice System Test

1. Upload test firmware to AtomS3R
2. Verify microphone captures audio
3. Test speaker output for audio feedback
4. Check I2C communication between devices

Software Deployment

Prerequisites

```bash
# Install PlatformIO
pip install platformio

# Setup project
./build.sh setup
```

Build and Flash

```bash
# Build all firmware
./build.sh build

# Flash AtomS3R (voice processor)
./build.sh flash atoms3

# Flash ESP32-S3 Feather (display controller)
./build.sh flash feather
```

Monitor and Debug

```bash
```

```
# Monitor AtomS3R output
./build.sh monitor atoms3

# Monitor Feather output
./build.sh monitor feather
```

System Operation

Registration Flow

1. Press gamepad button A to enter registration mode
2. System displays "RECORDING" on TFT screen
3. LED matrix shows blue status indicator
4. User speaks keyword clearly for 3 seconds
5. System processes voice and assigns number
6. Assignment number displayed on TFT and LED matrix
7. Audio confirmation played through speaker

Retrieval Flow

1. User approaches system and speaks keyword
2. Voice recognition processes input
3. If match found: displays assigned number
4. If no match: prompts for retry or staff assistance
5. Staff can override using gamepad controls

Troubleshooting

Common Issues

No display output:

- Check TFT connections (CS, DC, RST pins)
- Verify backlight power (GPIO 45)
- Ensure SPI bus is properly initialized

I2C communication errors:

- Verify SDA/SCL connections
- Check device addresses (no conflicts)

- Ensure pull-up resistors are present
- Use logic analyzer if available

Voice processing issues:

- Check microphone initialization
- Verify speaker connections
- Test with known good audio samples
- Monitor serial output for error codes

LED matrix not working:

- Verify I2C address (0x30)
- Check power supply (adequate current)
- Test with simple fill/clear commands
- Verify IS31FL3741 library installation

Error Codes

```
0x01 - Voice capture failure
0x02 - Keyword processing error
0x03 - Storage operation failed
0x04 - I2C communication timeout
0x05 - Hardware initialization error
```

Performance Optimization

Power Management

- Use sleep modes between voice captures
- Adjust LED brightness based on ambient light
- Implement timeout for idle states

Memory Usage

Memory Usage

- Limit voice profile storage to 100 entries
- Use efficient data structures for I2C communication
- Implement circular buffer for audio processing

Real-time Constraints

- Voice processing should complete within 2 seconds
- I2C communication timeout set to 100ms
- Display updates at 10Hz for smooth operation

Hackathon Demo Script

Demo Scenario (5 minutes)

1. **Setup** (30 seconds)
   - Power on system, show ready state
   - Explain hardware components briefly
2. **Registration** (2 minutes)
   - Register demo user with keyword "helsinki winter"
   - Show visual feedback on displays
   - Demonstrate assigned number display
3. **Retrieval** (2 minutes)
   - Same user returns and speaks keyword
   - System recognizes voice and displays number
   - Show error case with different user
4. **Features** (30 seconds)
   - Demonstrate gamepad controls
   - Show slider volume adjustment
   - Highlight LED status indicators

Key Talking Points

- Contactless operation eliminates lost tickets

- Voice biometrics provide natural security
- Scalable for large venues (concerts, gyms)
- Works offline without internet dependency
- Handles multiple languages and accents

Extension Ideas

Advanced Features

- Gesture control using accelerometer
- Multi-language keyword support
- Analytics dashboard for usage patterns
- Integration with venue management systems
- Mobile app companion for staff

Alternative Applications

- Hotel room key replacement
- Secure storage lockers
- Vehicle identification in parking
- Equipment checkout in gyms
- Laboratory sample tracking

This system transforms the traditional cloakroom experience into an engaging, technology-forward interaction while solving real operational challenges through innovative hardware integration and voice recognition technology.