Karaoke Machine

Name	Giurgiu Andrei-Ștefan
Group	335CA

Introduction

The project consists of creating a karaoke mechanism, using a speaker for the instrumental and an LCD screen for the lyrics. The user can choose from a preset selection of songs, loaded on a microSD card. The songs which are listed at the beginning on the screen, can be selected using buttons. The speaker volume can also be adjusted using a potentiometer.

The goal of the project is to create a relaxing and fun atmosphere for the users.

General description

The **ESP32** is the main component of the project, since it will be in charge of reading data from the card and send the audio signal to an amplifier using the I2S protocol.

The **MAX88357A amplifier** will take the digital signal from the ESP32 and transform it into a strong analogue signal. After this the sound will be sent to the speaker.

The main storage component is a **16GB microSD card**, formatted as Fat32. The instrumental files are stored in the `.mp3` format and the lyrics files in the `.lrc` format, which is a text format with timestamps before the text, so that syncing with the instrumental is easier.

The user interface is made of three classes of components: the **20×4 LCD display** with an I2C interface, **the volume adapter** and **the buttons**. The display is a simple LCD with an I2C module attached, which at the beginning will show the available songs on the device. Using the buttons, the user can select a song and play it.

Block Scheme

Hardware Design

The list of components used is:

- ESP32-WROOM-32D Microcontroller
- MAX98357A Amplifier
- MB102 Power Module
- LCD Display with PCF8574 I2C module
- microSDHC Card
- 40mm 3W Speaker
- MicroSDHC Reader Module
- Potentiometer
- Buttons
- 2x Breadboard

Component Pinout

Component	Pin Name	Connected To	Reason

ESP32-DEVKITC-32D	3V3	MB102 (VCC2 @ 3.3V) & Potentiometer (Top Pin)	Receives stable 3.3V power from the external supply (standalone mode) and provides the 3.3V reference voltage for the volume potentiometer.
	IO34	Potentiometer (Wiper)	ADC input to read the analog voltage (0-3.3V) to adjust the software volume.
	IO27	PLAY/PAUSE BUTTON	GPIO input with internal pull-up activated to control the playback state.
	IO14	UP BUTTON	GPIO input with internal pull-up activated to navigate up in the song list.
	IO13	DOWN BUTTON	GPIO input with internal pull-up activated to navigate down in the song list.
	GND	Common GND	Essential common ground reference for all power and data signals across the entire system.
	5V	Not Connected	Left disconnected because the ESP32 is powered directly via the 3.3V rail from the MB102.
	IO23	Micro SDHC reader (MOSI)	SPI Master Out Slave In: Sends read commands to the SD card.
	IO22	PCF8574 (SCL)	I2C Clock line to synchronize data transfers to the LCD.
	IO21	PCF8574 (SDA)	I2C Data line to display menus and lyrics on the LCD.
	IO19	Micro SDHC reader (MISO)	SPI Master In Slave Out: Stream audio (.mp3) and lyrics (.lrc) data to the ESP32.
	IO18	Micro SDHC reader (SCK)	SPI Clock line generated by the ESP32 to sync SD card communication.
	IO5	Micro SDHC reader (CS)	SPI Chip Select: Enables the SD card reader during data transfers.
	IO16	MAX98357A (DIN)	I2S Data Line (DOUT): Sends the raw digital audio stream to the amplifier.
	IO26	MAX98357A (BCLK)	I2S Bit Clock: Dictates the timing and speed of individual audio data bits.
	IO25	MAX98357A (LRC)	I2S Left/Right Clock (Word Select): Syncs the audio channels for the DAC.
MB102 Power Supply	VCC1 (Set to 5V)	MAX98357A (Vin), PCF8574 (VCC), Micro SDHC reader (VCC)	Provides heavy-duty 5V power to power-hungry and 5V-logic components to ensure maximum volume, clear LCD contrast, and stable SD card reads.
	VCC2 (Set to 3.3V)	ESP32 (3V3)	Supplies a clean, regulated 3.3V directly to the ESP32 power rail for safe, standalone operation.
	GND	Common GND	Central grounding hub for the breadboard circuit.

MAX98357A	LRC	ESP32 (IO25)	Receives the audio channel sync timing.
	BCLK	ESP32 (IO26)	Receives the digital audio bit timing.
	DIN	ESP32 (IO16)	Receives the digital I2S audio data stream.
	GAIN	Common GND	Anchors the pin to GND to set a 12dB gain and prevents it from floating like an antenna, **eliminating background hiss**.
	SD	Not Connected	Left floating to keep the amplifier always active.
	GND	Common GND	Completes the power loop and provides audio ground reference.
	Vin	MB102 (VCC1 @ 5V)	Power input to drive the audio speaker at full efficiency.
	+	Speaker (+)	Positive terminal for the amplified analog audio output.
	-	Speaker (-)	Negative terminal for the amplified analog audio output.
PCF8574	VCC	MB102 (VCC1 @ 5V)	Power supply for the I2C backpack and the LCD backlight.
	GND	Common GND	Completes the power circuit for the display interface.
	SDA	ESP32 (IO21)	I2C data interface for text communication.
	SCL	ESP32 (IO22)	I2C clock interface for text communication.
Micro SDHC reader	CS	ESP32 (IO5)	Listens for the SPI activation signal from the microcontroller.
	SCK	ESP32 (IO18)	Receives the SPI bus clock signal.
	MOSI	ESP32 (IO23)	Receives instructions from the ESP32.
	MISO	ESP32 (IO19)	Transmits the requested files back to the processor.
	VCC	MB102 (VCC1 @ 5V)	Safe 5V source to handle transient current spikes during SD card read operations.
	GND	Common GND	Completes the power loop for the reader module.
Potentiometer	Top Pin	ESP32 (3V3)	Connects to the safe 3.3V rail to set the upper limit of the voltage divider.
	Wiper	ESP32 (IO34)	Delivers a variable voltage (0-3.3V) to the ADC pin based on the knob position.
	Bottom Pin	Common GND	Connects to ground to set the lower limit of the voltage divider.
PLAY/PAUSE BUTTON	Pin 1	ESP32 (IO27)	Interconnects the button to the hardware interrupt pin on the ESP32.
	Pin 2	Common GND	Pulls the GPIO to LOW when pressed, fighting the internal pull-up resistor to register a click (active-LOW logic).
UP BUTTON	Pin 1	ESP32 (IO14)	Interconnects the button to the track navigation system.
	Pin 2	Common GND	Pulls the GPIO to LOW when pressed, fighting the internal pull-up resistor (active-LOW logic).

DOWN BUTTON	Pin 1	ESP32 (IO13)	Interconnects the button to the track navigation system.
	Pin 2	Common GND	Pulls the GPIO to LOW when pressed, fighting the internal pull-up resistor (active-LOW logic).
Speaker	+	MAX98357A (+)	Connects to the positive terminal of the audio transducer.
	-	MAX98357A (-)	Connects to the negative terminal of the audio transducer.

Electrical Scheme

Software Design

Under construction.

This project will be developed using the PlatformIO extension in Visual Studio Code. I will use Arduino for the main framework. Other libraries that will be included are:

- **ESP32-AudioI2S**, this library abstracts the interaction with the amplifier via I2S and the decoding of the `.mp3` files
- **LiquidCrystal_I2C**, this library abstracts the interaction with the LCD display's control module, PCF8574

In order to not have glitching or interrupting music, I decided to use **FreeRTOS** tasks for my project. There will be three main tasks:

- The menu task, where the user views the available songs and picks one.
- The lyric task, where the text is sent to the LCD at the correct timestamps and button state is monitored.
- The audio task, which will be the task with the highest priority, since sound quality is crucial.

More details after I finish implementing the firmware.

Results

To be determined after Software Milestone.

Concluzii

To be determined after Software Milestone.

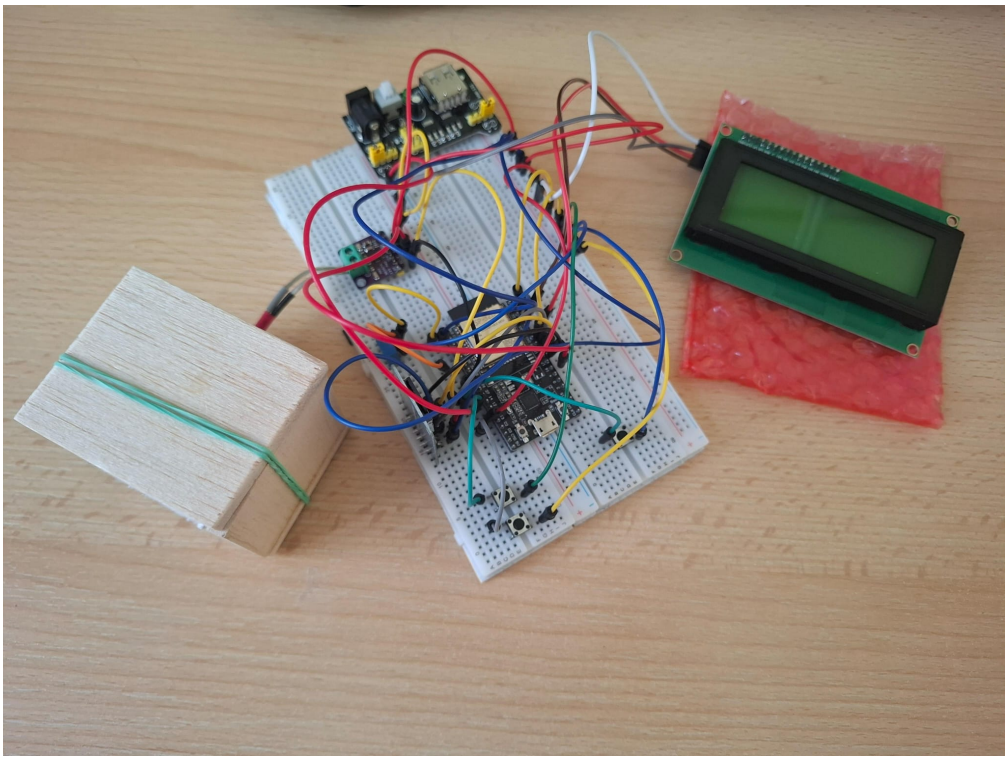
Download

Click here.

Journal

- 15.04.2026: First discussion with the assistant regarding the project theme.
- 05.05.2026: Partial creation of the technical documentation, which contains the project theme, block diagram and list of components.
- 08.05.2026: Add the electrical scheme of the project.
- 09.05.2026: Add the component pinout and refined the general description section.
- 12.05.2026: Refine the electrical scheme and add a short description of the software.
- 16.05.2026: Add simple demo.

Demos



Demo video

I did a small demo, where I just played the audio to see if the ESP32 can read the microSD card and if the speaker works. Also, in the video, you can see that the I2C module is connected and gets the text from the ESP32 that says “SD card mounted successfully”.

Resources

All the lyric files were originally taken from lrclib.net and preprocessed using Audacity in order to sync the timestamps with the instrumental.

Datasheets

Component	Link Datasheet
ESP32-WROOM-32D	Datasheet microcontroller
Amplifier MAX98357A	Datasheet MAX98357A
LCD 20×4	Datasheet display
MB102 Power supply module	Datasheet MB102
MicroSDHC reader module	Datasheet MicroSDHC

Export to PDF