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ITI Final Project

ARM Project

TV-show Selector

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1 .Introduction

1.1 Overview

The TV-Show Selector Program represents a cutting-edge solution designed to revolutionize the way users interact with their favorite TV shows. By leveraging the power of two ARM microcontrollers and an array of sophisticated hardware components, this program offers an unparalleled level of convenience, interactivity, and entertainment.

Traditionally, selecting TV shows from a vast array of options can be a cumbersome and time-consuming task. The TV-Show Selector Program aims to streamline this process by providing users with an intuitive and visually appealing interface that simplifies show discovery and selection.

At the core of the TV-Show Selector Program lies a carefully curated selection of hardware components, meticulously integrated to deliver a cohesive and immersive user experience. LED matrix displays, TFT screens, LCDs, LEDs, and buttons work in harmony to provide users with a seamless and intuitive interaction platform.

To ensure optimal performance and compatibility, the TV-Show Selector Program incorporates custom-developed drivers for each hardware component. These drivers are meticulously crafted to interface seamlessly with the ARM microcontrollers, enabling precise control and efficient operation of the entire system.

1.2 Project Goals

- Create an interactive platform for browsing and selecting TV shows.
- Implement seamless communication between two microcontrollers for enhanced functionality.
- Develop custom drivers to control various hardware components, ensuring optimal performance and compatibility.
- Integrate diverse hardware elements to construct a cohesive and visually engaging interface.

2 .Hardware Components

2.1 ARM Microcontrollers

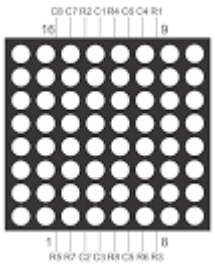
Power and Versatility of ARM Architecture

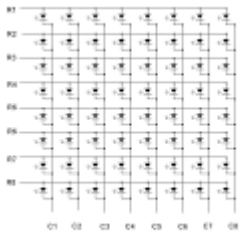
The STM32F401CC microcontroller, based on ARM Cortex-M4 architecture, stands as a testament to the power and versatility offered by ARM technology. Featuring a robust 32-bit RISC core, the Cortex-M4 offers a blend of high performance, energy efficiency, and a rich set of peripherals, making it an ideal choice for a wide range of embedded applications.

Key Features of STM32F401CC

- Performance: With a maximum CPU frequency of up to 84 MHz and a floating-point unit (FPU), the STM32F401CC delivers exceptional computational performance, enabling rapid execution of complex algorithms and tasks.
- Peripherals: Equipped with a plethora of peripherals including GPIOs, timers, USART, SPI, I2C, ADC, and more, the microcontroller offers extensive capabilities for interfacing with external devices and sensors, facilitating seamless integration into diverse projects.
- Memory: Featuring up to 512 KB of Flash memory and 96 KB of SRAM, the STM32F401CC provides ample storage space for program code and data, ensuring efficient operation and flexibility in application development.
- Low Power Operation: Incorporating advanced low-power modes and techniques, the microcontroller enables energy-efficient operation, making it suitable for battery-powered and energy-conscious applications.
- Rich Ecosystem: Supported by a comprehensive development ecosystem comprising vendor-provided software libraries, development tools, and community resources, the STM32F401CC simplifies the process of firmware development and debugging, accelerating time-to-market for embedded projects.

2.2 LED Matrix Displays

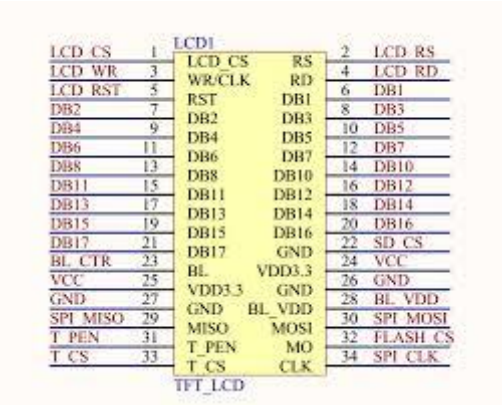




LED matrix displays consist of an array of individually addressable LEDs arranged in rows and columns. These displays offer a versatile platform for presenting visual information, making them ideal for displaying show selection options in the TV-Show Selector Program. Here is how LED matrix displays enhance user interaction:

- Visual Feedback: LED matrix displays provide immediate visual feedback to users, highlighting selected show options and indicating system status.
- Dynamic Content: With the ability to display graphics and animations, LED matrix displays can present a wide range of information in a dynamic and engaging manner.
- User Engagement: By presenting show selection options in a clear and dynamic format, LED matrix displays enhance user engagement and interaction with the program.
- Customization: LED matrix displays offer flexibility for customizing display content and layout, allowing for tailored user experiences and branding opportunities.

2.3 TFT Screen

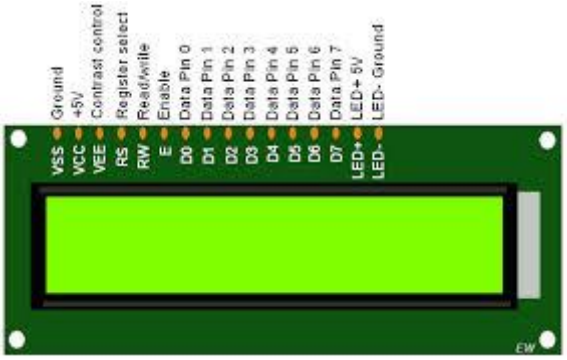


TFT screens, or Thin Film Transistor screens, are high-resolution displays capable of displaying detailed information with vibrant colors and crisp visuals. In the TV-Show Selector Program, TFT screens serve as primary displays for presenting detailed show information. Here is how TFT screens enrich user interaction:

- High Resolution: TFT screens offer high-resolution displays, allowing for the presentation of detailed show information such as images, descriptions, and episode lists.
- Vivid Colors: With vibrant colors and excellent color reproduction, TFT screens provide users with an immersive viewing experience, enhancing the visual appeal of the program.

- Rich Content: TFT screens enable the presentation of rich multimedia content, including images, videos, and text, enhancing the depth and quality of show information.
- Touch Interaction: Some TFT screens feature touch capabilities, allowing for intuitive touch-based interaction with the program, further enhancing user engagement and usability.

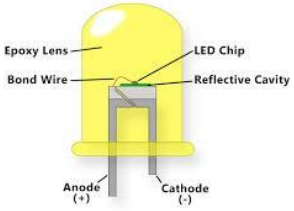
2.4 LCD



LCDs, or Liquid Crystal Displays, serve as secondary displays in the TV-Show Selector Program, offering supplementary information and system status updates. Here is how LCDs contribute to the user experience:

- Readability: LCDs provide clear and easy-to-read text, graphics, ensuring users can quickly and accurately access supplementary information, and system status updates.
- Space Efficiency: LCDs are compact and space-efficient, making them ideal for displaying essential information without occupying significant screen real estate.
- Low Power Consumption: LCDs consume minimal power, contributing to overall system energy efficiency and extending battery life in portable applications.
- Cost-Effectiveness: LCDs are cost-effective display solutions, providing a balance between performance and affordability for embedded system applications.

2.5 LEDs

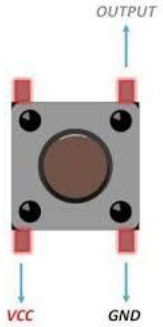


LEDs serve as status indicators and visual cues in the TV-Show Selector Program, helping users navigate through the program effortlessly and providing important feedback. Here is how LEDs enhance user interaction:

- Status Indication: LEDs provide visual cues to indicate system status, such as power on/off, show selection confirmation, and system errors, enhancing user understanding and interaction.
- User Guidance: By illuminating specific LEDs in response to user actions, the system can guide users through the program's navigation and selection process, ensuring intuitive operation.

- Feedback Mechanism: LEDs serve as a feedback mechanism, providing immediate visual confirmation of user inputs and system responses, enhancing user confidence and usability.
- Customization: LEDs can be customized in color, brightness, and pattern to suit specific application requirements and user preferences, allowing for tailored user experiences and branding opportunities.

2.6 Buttons



Buttons are the primary mode of user input in the TV-Show Selector Program, enabling users to navigate through show options and make selections with ease. Here is how buttons facilitate user interaction:

- Tactile Feedback: Buttons provide tactile feedback to users upon pressing, confirming the activation of the input and enhancing user confidence and satisfaction.
- Intuitive Operation: With clearly labeled buttons and logical placement, users can intuitively navigate through show options and select without the need for extensive learning or training.
- Reliability: Buttons offer reliable input control, ensuring consistent and accurate operation even under challenging conditions such as environmental noise or user fatigue.
- Accessibility: Buttons are accessible to users of all abilities, making them an inclusive input method suitable for a diverse range of users and usage scenarios.

3 .Drivers

In the TV-Show Selector Program, various drivers are employed to interface with hardware components and peripherals, facilitating seamless operation and interaction. Each driver plays a crucial role in enabling communication, control, and data exchange within the system. Let us explore the drivers utilized in the project:

3.1 GPIO (General Purpose Input/Output)

The GPIO driver enables the microcontroller to interact with external devices such as buttons, LEDs, and sensors by configuring GPIO pins as inputs or outputs. It provides functions for setting pin modes, reading input values, and controlling output states, facilitating user input and system feedback.

3.2 RCC (Reset and Clock Control)

The RCC driver manages clock configuration and peripheral clock gating, ensuring proper initialization and operation of the microcontroller and its peripherals. It allows for configuring system and peripheral clock frequencies, enabling efficient system performance and power management.

3.3 NVIC (Nested Vector Interrupt Controller)

The NVIC driver handles interrupt requests from peripheral devices and manages interrupt priorities and handling. It enables the microcontroller to respond to external events promptly and efficiently, ensuring timely execution of interrupt service routines (ISRs) and system tasks.

3.4 STK (SysTick Timer)

The STK driver controls the SysTick timer, a system timer used for generating periodic interrupts and timekeeping. It provides functions for configuring the SysTick timer frequency and handling timer interrupts, facilitating time-based operations and task scheduling within the system.

3.5 USART (Universal Synchronous/Asynchronous Receiver/Transmitter)

The USART driver enables serial communication between the microcontroller and external devices via UART (Universal Asynchronous Receiver/Transmitter) or USART (Universal Synchronous/Asynchronous Receiver/Transmitter) protocols. It allows for transmitting and receiving

data asynchronously or synchronously, facilitating communication with peripherals such as TFT screens and LED matrix displays.

3.6 EXTI (External Interrupt)

The EXTI driver manages external interrupt lines and handles interrupt requests from external sources such as buttons and sensors. It enables the microcontroller to respond to external events and trigger interrupt service routines (ISRs) based on specific interrupt conditions, enhancing system responsiveness and user interaction.

3.7 SPI (Serial Peripheral Interface)

The SPI driver facilitates serial communication between the microcontroller and peripheral devices using the SPI protocol. It enables high-speed data transfer and bidirectional communication with devices such as TFT screens and external memory modules, enhancing system connectivity and versatility.

3.8 LED Matrix Driver

The LED matrix driver provides functions for controlling LED matrix displays, including initializing display configurations, setting pixel values, and refreshing display contents. It enables the microcontroller to present visual information and graphics on LED matrix displays, enhancing user interaction and feedback.

3.9 TFT Screen Driver

The TFT screen driver manages communication with TFT screens, including initializing display parameters, sending display commands, and transferring image data. It enables the microcontroller to render high-resolution graphics and text on TFT screens, providing users with detailed show information and visual feedback.

3.10 LCD Driver

The LCD driver interfaces with LCD displays, controlling display initialization, data transmission, and cursor positioning. It enables the microcontroller to present supplementary information and system status updates on LCD displays, enhancing user interaction and providing essential feedback.

4 .Project Architecture

Components:

LED Matrix (Rx): Displays visual information such as show names.

TFT Display (Tx): Displays images related to the selected show.

LCD Display (Tx): Displays the selected show name.

Buttons (Tx): Four buttons used for user interaction.

LEDs (Rx): Indicators controlled by the Rx microcontroller.

Microcontrollers:

Transmitter (Tx):

- Responsible for controlling the TFT display, LCD display, buttons, and USART communication for transmitting data to the receiver.
- Utilizes GPIO pins for button input and USART pins for communication.
- Executes specific actions based on button presses, such as displaying show names on the LCD and corresponding images on the TFT.

Receiver (Rx):

- Controls the LED matrix and LEDs.
- Receives data from the transmitter via USART and performs actions accordingly.
- Displays show names on the LED matrix and controls LEDs as indicators.

Communication:

USART communication protocol is used for bidirectional data transfer between the transmitter and receiver.

Transmitter sends commands to the receiver based on user input from the buttons.

Receiver processes commands received from the transmitter and controls the LED matrix and LEDs accordingly.

Main Functions:

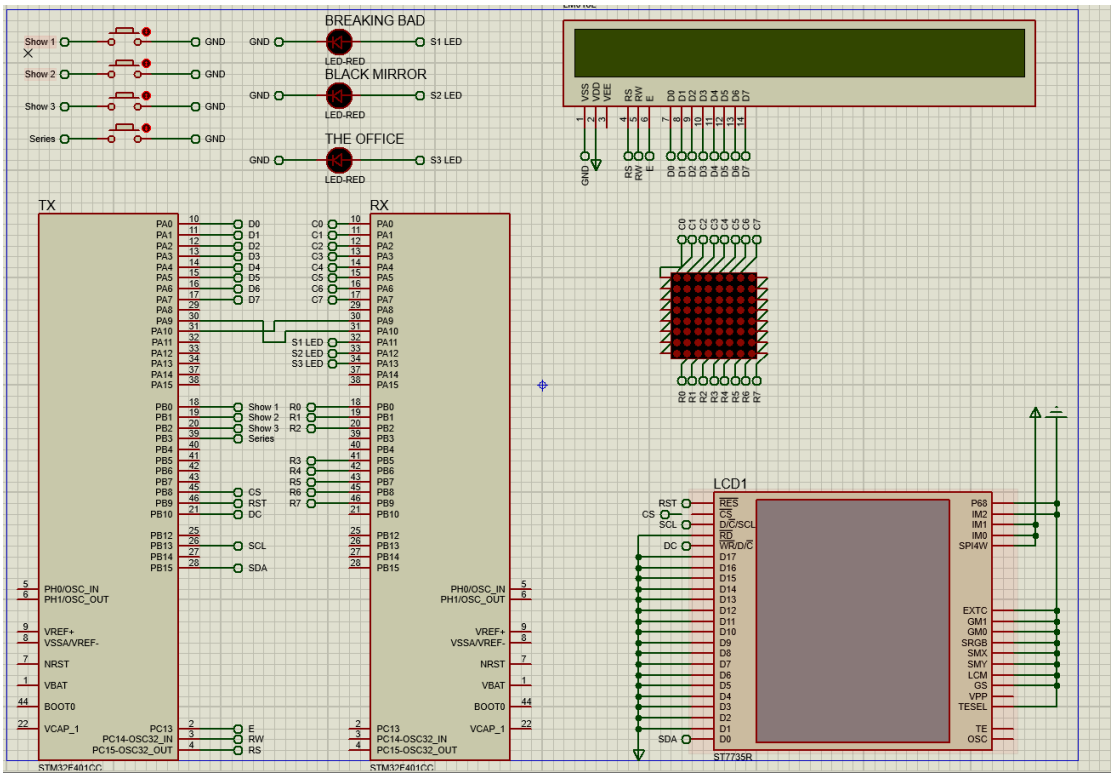
Transmitter (Tx):

- Initializes peripherals such as USART, GPIO, LCD, and TFT displays.
- Waits for button presses and sends corresponding commands to the receiver.
- Displays show names on the LCD and images on the TFT display.

Receiver (Rx):

- Initializes the LED matrix and GPIO pins.
- Waits for commands from the transmitter via USART.
- Displays show names on the LED matrix based on received commands.
- Controls LEDs as indicators.

This architecture ensures seamless interaction between the user and the system, allowing them to select and view different shows with corresponding visual feedback.



5 .Conclusion

5.1 Summary

The TV-Show Selector Program provides an intuitive interface for users to browse and select TV shows. It integrates various hardware components controlled by ARM microcontrollers and custom drivers to deliver a seamless user experience.

5.2 Future Enhancements

Future enhancements may include additional features such as:

- Implementing remote control functionality.
- Adding support for more TV shows and multimedia content.
- Integrating voice recognition for hands-free operation.