Exploring Multimedia Applications of a Microcontroller

1st Ria Mary Suresh
School Of Computer Science and Engineering
Vellore Institute of Technology
Vellore, Tamil Nadu, India

2nd Aastha Gupta
School Of Computer Science and Engineering
Vellore Institute of Technology
Vellore, Tamil Nadu, India

3rd Rashmi MT
School Of Computer Science and Engineering
Vellore Institute of Technology
Vellore, Tamil Nadu, India

4 th Namish Gupta
School Of Computer Science and Engineering
Vellore Institute of Technology
Vellore, Tamil Nadu, India

5th Navyanth Reddy
School Of Computer Science and Engineering
Vellore Institute of Technology
Vellore, Tamil Nadu, India

Abstract—With the development of computers, batteries, and MP3, people were able to carry hundreds of tunes in their pockets thanks to MP3 players. Although Kane Kramer applied for a patent for a digital audio player in 1981, the first MP3 player to be sold commercially, the MPman, wasn't released until 1997. However, few individuals in the record label industry paid it much attention. They anticipated the downfall of MP3 players. But they were mistaken. The introduction of digital music players and P2P apps made it simple for consumers to transport hundreds of tunes. Again, this wouldn't have been feasible if it weren't for the MP3 format.

I. Introduction

Portable music players have existed for decades, with the first truly portable consumer device released by Sony in 1979. Known as the “Walkman”, this cassette player for the first time allowed people to easily carry hours of music on their persons. Since then, technology in this field abruptly moved away from analog storage mediums to strictly digital ones. The CD player was the next revolution, as it was the first foray into mainstream digital music mediums. With the trend of shrinking the sizes of consumer electronics, and the growing popularity of sharing music online, the CD player was given up for flash-based music players. Dubbed the MP3 player, these devices allowed users far more convenience in customizing which music they wanted to load onto their players. Since flash memory was (and to some degree, still is) fairly expensive in terms of capacity per monetary cost, a shift to mechanical hard-disk drive based players began.

The system/software design of the MP3 player, as well as its basic operation and functioning, will all be covered in this research paper.

II. Proposed System Design

A basic MP3 player system design would involve the following components:

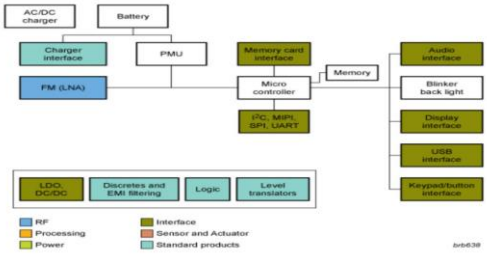
1. Storage: MP3 files are typically stored on a flash memory chip or a hard drive.
2. Processor: A microcontroller or microprocessor is required to control the various functions of the MP3 player.
3. Digital-to-Analog Converter (DAC): The MP3 files are stored in a digital format, and must be converted to an analog signal to be played through speakers or headphones.
4. Amplifier: The analog signal is then amplified by an amplifier before being sent to the speakers or headphones.
5. User Interface: A user interface is required to control the MP3 player. This can include physical buttons, a touch screen, or a combination of both.
6. Battery: A battery is required to power the MP3 player.
7. Audio Codec: An audio codec is used to encode and decode the audio data. The most common audio codec used in MP3 players is the MPEG-1 Audio Layer 3 codec.
8. Audio Playback Software: An audio playback software is needed to play the audio files on the MP3 player. This software is responsible for decoding the audio files, and sending the digital signal to the DAC for conversion.

9. File Management: The MP3 player needs to have a file management system to organize the music files, create playlists, and delete files.
10. Connectivity: An MP3 player can have various types of connectivity options such as USB, Bluetooth, Wi-Fi, or NFC. These connectivity options can be used to transfer music files to the MP3 player or to connect the device to external speakers or headphones.

Overall, the system design of an MP3 player involves a combination of hardware and software components that work together to provide a seamless and enjoyable listening experience for users. Microcontrollers are commonly used in MP3 players as they provide the necessary processing power and control to manage the various components of the device. Here are some ways in which microcontrollers are used in MP3 players:

1. User interface: The microcontroller can control the user interface of the MP3 player, including buttons, display screens, and navigation systems.
2. Audio processing: The microcontroller can manage the digital signal processor (DSP) that decodes the compressed digital audio data and converts it into an analog signal that can be played through the speakers or headphones.
3. Storage: The microcontroller can manage the storage of music files in the MP3 player's memory, including organizing the files and retrieving them for playback.
4. Power management: The microcontroller can manage the power usage of the MP3 player, including battery monitoring, charging, and power-saving features.
5. Connectivity: The microcontroller can manage the MP3 player's connectivity features, including USB and Bluetooth connections.
6. System control: The microcontroller can manage the overall system control of the MP3 player, including startup and shutdown procedures, error handling, and system maintenance.

Overall, the use of microcontrollers in MP3 players enables efficient and reliable operation of the device, allowing for a smooth and user-friendly experience for the end user.



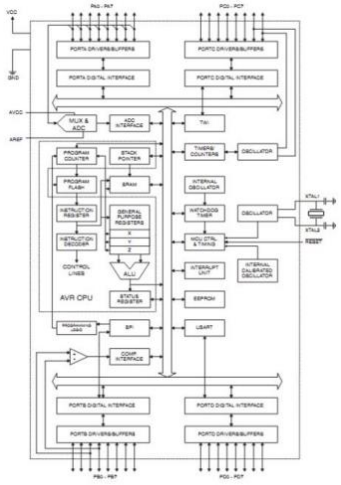
III. Working of MP3 Player

1. An MP3 player is an electronic device that is designed to play digital audio files in the MP3 format. MP3 players typically consist of a microprocessor, storage memory, a digital-to-analog converter (DAC), an amplifier, and an audio output jack. When an MP3 file is played on an MP3 player, the microprocessor retrieves the digital data from the storage memory and sends it to the DAC, which converts the digital data into analog audio signals.
2. The amplifier then amplifies the audio signals, and the audio output jack sends the signals to headphones or speakers, where they can be heard by the listener. In addition to playing MP3 files, many MP3 players also support other digital audio formats, such as WAV, AAC, and WMA. Some MP3 players also have additional features, such as FM radio, voice recording, and built-in speakers.
3. The basic operation of an MP3 player involves storing digital audio files on the device's memory, selecting the desired file to play using the player's interface, and then playing the file through headphones or speakers. MP3 players can be connected to a computer via USB, allowing users to transfer digital audio files to and from the player's memory. In recent years, many MP3 players have been replaced by smartphones, which can also play digital audio files and offer additional features such as internet connectivity and video playback. However, MP3 players remain popular among people who prefer a dedicated device for listening to music and other audio content.
4. Microprocessors are an essential component of MP3 players, as they are responsible for the processing and storage of audio files.
5. A microprocessor is a small computer on a single integrated circuit chip that can execute instructions and perform calculations. It acts as the brain of the MP3 player, controlling all of its functions, including reading the audio files from memory, decoding them, and playing them back. The process of playing an MP3 file on an MP3 player involves several steps, which are all controlled by the microprocessor.
6. When a user selects a song to play, the microprocessor reads the file from the storage memory, which is typically a flash memory chip. It then decodes the compressed audio data using an algorithm called the MPEG Audio Layer III, which is why the device is called an MP3 player. The microprocessor then converts the digital audio data into an analog signal that can be sent to the headphones or speakers.

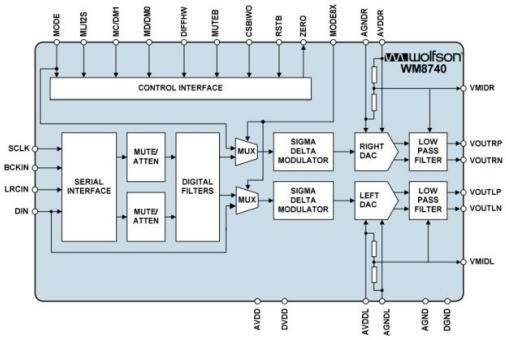
7. It also controls the volume and other playback features, such as equalization and playback speed. In addition, the microprocessor manages the user interface of the MP3 player, which includes the display, buttons, and other controls. There are several different types of microprocessors that are used in MP3 players, including those made by companies such as Texas Instruments, ARM Holdings, and Samsung.
8. These processors are often optimized for low power consumption and high performance, as they need to be able to handle complex audio processing tasks while still providing long battery life. Overall, the microprocessor is a critical component of an MP3 player, as it is responsible for processing and playing back audio files, managing the user interface, and controlling other features of the device.
9. Understanding how these microprocessors work is essential for researchers studying the design and development of MP3 players, as well as those interested in exploring the broader field of embedded.

IV. System Design

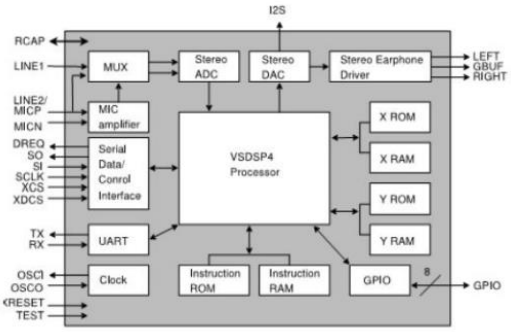
1. Main microcontroller (Atmel ATMEGA32A): This microcontroller's comprehensive peripheral set, including its 32kB of flash program memory, SPI, I2C, UART, three timers, and 33 GPIOs, makes it an excellent starting place. It is more than quick enough to move data around because it can operate at up to 16MHz. Because of its low active power consumption (1mA) and numerous sleep modes that further lower current draw to below 1A, it is also perfectly suited for a portable application.



2. Stereo Audio DAC (Wolfson WM8740): The audiophile community holds high regard for this premium audio DAC chip, which can be found in some of the costliest commercial CD players. In comparison to its successors (WM8741 and WM8742), which cost twice as much and on paper only have somewhat greater specifications, this is a superior option.



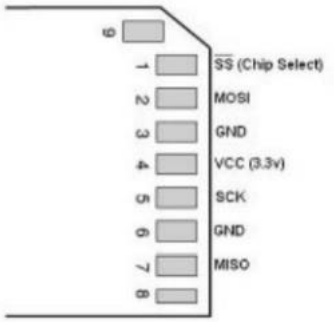
3. Audio Decoder Chip (VLSI VS1053): The VLSI VS1053 is a decoder chip that can decode a wide range of audio formats, including MP3, OGG, FLAC, WMA, and AAC. It also offers a number of outputs options and consumes little power. The chip can be used in conjunction with the ATMEGA32A to carry out additional tasks in the music player because it is essentially a DSP microcontroller, which could increase functionality. It also offers versatility, as using the analogue output, which requires no additional components, can be used to reduce complexity or power consumption. However, the audio data is sent to the WM8740 via the I2S output because the goal of this architecture is to produce the highest possible sound quality.



4. Real Time Operating System (RTOS): This real-time embedded operating system is an essential component even though it isn't a physical portion. The pre-emptive scheduler's ability to provide quick context switching and minimal latency more than

made up for the small complexity increase associated with employing an RTOS.

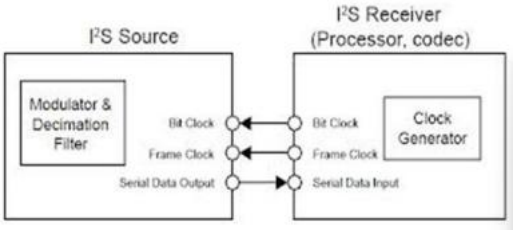
5. SD Card/ FAT File System: The information for the music files is kept on the SD card, a flash-based storage device. Conveniently, SPI is the default communication protocol used by SD cards, making the interface with the microcontroller simple.



V. Conclusion

1. We focused on one particular area of research, namely multimedia applications. We narrowed down our research to one device which reflect the usage and componential overview of a microcontroller i.e., 3-D MP3 players enveloping the Multimedia sphere.
2. The MP3 player can be thought of as a technological advancement that was introduced into society to help its users feel more exhilarated, comfortable, happy, and less depressed.
3. The popularity of MP3 players has significantly increased in recent years as a result of improved cost and advancements in smartphones and tablets that enable extensive connectivity
4. Despite the fact that portable audio devices have been sticking along for long, they have relatively little storage. People will be able to carry their own portable jukebox that will serve as the background music for their daily lives if a mass storage device is added.
5. We discussed about how a microcontroller induces sound in a MP3 player using two methods:
6. Playing audio using an external sound playback device: Here, all the record and play functions are controlled by the microcontroller i/o ports.
7. The microphone can be connected directly to the chip's input pin thanks to the pre-amplifier that is included into these chips. Additionally, they include an integrated output audio amplifier so you may connect a speaker directly to the APR9600 chip's audio output. The APR33A3 offers an extended recording time of 680 seconds compared to the preceding APR9600, which has a limited recording time of a few seconds.

8. Playing audio from an inbuilt microcontroller with I2S system: Here, I2S=Inter IC Sound, transfers audio data between chips.
9. If the audio clip is concise, the RAW/PCM audio data may be stored in the microcontroller's memory and then transmitted to an audio DAC using the controller's I2S connection. Implementing the I2S protocol might be challenging since it relies on a precise clock to send and receive data. The dsPIC family of controllers from Microchip has the lowest cost I2S interface controllers.



10. The limitations of usage of microcontrollers were discussed, drawing the conclusion that the main issue is that the Microcontroller's memory utilization requires that the number of timers used be constrained. Increasing the number of timers requires more memory which can solve this drawback.
11. In our presentation, project we were successful in constructing an efficient and functionable MP3 player simulation using Proteus software and code development.
12. Future of Microcontrollers: With a thousand of already existing applications in the areas of work, education and healthcare, now microcontrollers will be aiming to transform our life by IOT (Internet of Things).

VI. References

http://repository.wyb.ac.lk/bitstream/handle/1/1617/ASRITE-2015-263.pdf?sequence=2

http://utpedia.utp.edu.my/id/eprint/7927/1/2005%20-%20SOLID-STATE%20MP3%20PLAYER.pdf

https://digitalcommons.calpoly.edu/cgi/viewcontent.cgi?article=1112&context=eesp