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Preloaded Text-To-Speech For Visually Disabled

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ABSTRACT

This paper presents a compact and efficient preloaded text-to-speech (TTS) system developed using an Arduino Uno, DFPlayer Mini audio module, and a speaker interface. The system stores pre-recorded voice messages on an SD card and plays them based on user-defined triggers, eliminating the need for real-time speech synthesis. A simple control algorithm enables the Arduino Uno to select and activate audio files with low latency and high reliability. The DFPlayer Mini provides clear audio output while minimizing circuit complexity and overall cost. Experimental testing demonstrates accurate playback, fast response time, and stable performance. The proposed design is suitable for low-cost embedded applications such as automation alerts, assistive devices, educational tools, and smart electronic products. This work highlights the practicality and scalability of using preloaded audio-based TTS solutions in resource-constrained environments.

Keywords:
Arduino Uno, DFPlayer Mini, Text-to-Speech (TTS), Preloaded Audio Playback, Embedded Systems, Voice Alert System, SD Card Storage, Automation.

INTRODUCTION

Voice-based systems are increasingly used in automation, safety, consumer electronics, and assistive technologies due to their ability to deliver information quickly and intuitively. Traditional text-to-speech (TTS) solutions rely on complex algorithms and high-performance processors, making them unsuitable for low-cost or resource-constrained embedded applications. To address this limitation, preloaded audio playback systems provide a simple and efficient alternative by using stored voice prompts instead of real-time speech synthesis.

In this work, a preloaded text-to-speech system is designed using an Arduino Uno microcontroller and a DFPlayer Mini audio module. The DFPlayer Mini enables high-quality audio playback directly from an SD card, reducing hardware complexity and processing load on the microcontroller. The Arduino Uno is programmed to trigger specific audio files based on user inputs or sensor conditions, enabling flexible and reliable operation.

The system is compact, cost-effective, and easy to integrate into various applications such as alert systems, educational tools, home automation, and assistive devices for visually impaired users. The proposed design ensures low latency, stable performance, and ease of deployment, making it a practical solution for embedded voice-prompt requirements. This paper discusses the system architecture, implementation, testing results, and potential areas for future enhancement.

LITERATURE SURVEY

Sharma *et al.* [1] presented an early low-cost preloaded speech output system using Arduino and the DFPlayer Mini for public kiosk announcements. Their design mapped stored MP3 files to user inputs via push buttons and IR sensors, emphasizing modularity and simplicity. They demonstrated reliable playback of preloaded audio files without real-time synthesis. However, they noted SD card access delays and lack of error handling, limiting performance in high-reliability environments.

Deepa *et al.* [2] developed a wearable navigation assistant for visually impaired users using Arduino Nano and DFPlayer Mini. Human-recorded voice messages improved clarity and user comfort compared to robotic speech. Sensors and tactile switches triggered context-specific alerts such as obstacle detection. The system's limitation was low scalability, since new messages required manually updating the SD card.

Kumar *et al.* [3] proposed a multilingual classroom automation system using Arduino Mega and DFPlayer Mini for scheduled announcements. Integration with a real-time clock (RTC) allowed accurate audio triggering at fixed intervals. Their work showed that DFPlayer supports multilingual playback without additional software. Nonetheless, strict MP3 naming rules constrained flexibility in larger implementations.

Rajeswari and Prasanna [4] introduced a medicine reminder system for elderly individuals using Arduino UNO and DFPlayer Mini. Natural voice prompts enhanced medical adherence and reduced user confusion. User trials reported high clarity and ease of operation. However, the system lacked dynamic message updates and required external amplification in noisy conditions.

Zainuddin *et al.* [5] designed an interactive educational toy for early learners utilizing preloaded phonics and educational sounds. The DFPlayer Mini provided engaging and high-quality audio output for child-friendly learning. Their work demonstrated effective integration of MP3-based TTS in learning devices. Still, the system faced scalability issues due to increasing SD card storage needs and longer audio access times.

Mendez and Alvarez [6] implemented an industrial safety alerting system using Arduino UNO and DFPlayer Mini to deliver spoken hazard warnings. Their design ensured reliable real-time playback for events such as gas leaks or fire detection. DFPlayer's decoding stability supported continuous monitoring applications. However, factory-level noise required external amplification beyond the module's built-in output.

Rahman and Qureshi [7] proposed a speaking thermometer using sequential playback of numeric audio clips to construct temperature announcements. This modular approach enabled dynamic sentence formation using stored sound files. The system maintained clarity while avoiding complex speech synthesis. Its primary challenge was managing a large audio library and maintaining smooth timing between files.

Srinivasan and Harini [8] developed an RFID-based attendance system that announced student names upon card scanning. Preloaded audio feedback improved user interaction and reduced attendance errors. Their system demonstrated effective use of personalized MP3 messages. Scalability issues emerged when handling hundreds of audio files, leading to occasional playback delays.

Chan *et al*. [9] integrated preloaded speech modules into assistive robotics using Arduino-controlled DFPlayer Mini. The robot delivered predefined phrases in response to gestures and user commands. This approach ensured high-quality speech without burdening the microcontroller. Limitations included the inability to modify tone or speaking rate, restricting natural conversational behavior.

Datta and Banerjee [10] developed a security locker system featuring multilingual voice alerts using DFPlayer Mini. Their design reliably announced access events and warnings, enhancing usability. Testing showed consistent playback under stable power conditions. However, performance decreased in noisy or outdoor environments, highlighting the need for better amplification and noise filtering.

METHODOLOGY

The methodology followed in the development of the preloaded text-to-speech system consists of four major stages: hardware design, audio preparation, software implementation, and system integration. The overall workflow ensures reliable playback of pre-recorded voice messages while maintaining low system complexity.

Hardware Design:The hardware architecture is centered around the Arduino Uno, which functions as the primary controller. The DFPlayer Mini module is interfaced with the Arduino through serial communication (TX and RX pins) to handle MP3 decoding and audio playback. A micro-SD card is inserted into the DFPlayer to store pre-recorded voice files, and an 8Ω speaker is connected to the audio output pins. External power regulation and basic filtering components are included to ensure stable operation.

Audio File Preparation:Voice messages required for the system were recorded, edited for clarity, and converted into MP3 format. Each file was renamed according to the DFPlayer Mini's naming conventions (e.g., 0001.mp3, 0002.mp3) to ensure accurate indexing during playback. The finalized audio files were then stored on the micro-SD card used by the module.

Software Implementation:The Arduino IDE was used to develop the control logic that triggers specific audio files. Serial communication commands were implemented to control the DFPlayer Mini's functions such as play, pause, volume adjustment, and track selection. Conditional statements were programmed to activate audio playback based on defined inputs or sensor readings. The software was iteratively tested to minimize latency and ensure consistent response.

System Integration and Testing:After assembling the hardware and uploading the source code, the components were integrated into a complete functional unit. Multiple test cases were conducted to verify playback accuracy, volume stability, and system responsiveness. The system was evaluated under varying power conditions and using different sets of input triggers. Results confirmed that the preloaded TTS mechanism delivers reliable and low-latency voice output suitable for embedded applications.

BLOCK DIAGRAM

Fig. 1-Block diagram for preloaded text-to-speech for visually disabled

FLOW CHART

Fig 2-Flowchart of preloaded text-to-speech for visually disabled

RESULT AND DISCUSSION

5.1 RESULT

The proposed Preloaded Text-to-Speech (TTS) system was successfully implemented using an Arduino UNO microcontroller, a DFPlayer Mini MP3 module, a Micro SD card, and an external 8Ω speaker. The system operates reliably and delivers clear, human-recorded voice messages based on predefined trigger conditions.

Hardware Performance Summary

• The Arduino UNO correctly detects trigger inputs (button presses/sensor activations).
• The DFPlayer Mini reads MP3 files from the Micro SD card without delay and plays them instantly.
• The speaker output is loud and clear, with no distortion at normal volume levels.
• The Serial Monitor displays live status updates indicating which track is being played, confirming smooth command execution.

Fig.3 output of speech

Out-put Explanation

During testing, multiple pre-recorded audio messages such as “I’m hungry, I need food” were triggered and played through the speaker. The Serial Monitor displayed the following details in real time:

• Track Number Played – confirms which MP3 file (e.g., 0001.mp3) was selected.
• Trigger Event Message – indicates what caused the playback.
• Status Messages – “Playing Track…”, “Volume Set…”, etc., showing correct module communication.

The displayed output helps verify:

- Proper communication between Arduino and DFPlayer Mini
- Successful MP3 file detection
- Correct file naming and SD card reading
- Response speed of the system

Sample Output Table

Trigger Event	**MP3 File Played**	**Serial Monitor Status**	**Audio Output**
Button Press	0001.mp3	Playing Track 1	“I’m hungry, I need food”
Sensor ON	0002.mp3	Playing Track 2	“System Activated”
Timer Event	0003.mp3	Playing Track 3	“Please Wait”

Table-1-sample output table

From Table-1 and the Serial Monitor outputs, it is clear that the system plays the correct audio clips with minimal delay and high clarity.

CONCLUSION

The project titled "Preloaded Text-to-Speech Using Arduino and DFPlayer Mini" was successfully designed, implemented, and tested. The system demonstrated reliable performance in delivering high-quality, pre-recorded voice messages based on user-triggered events. By combining Arduino's simple digital control with the DFPlayer Mini's MP3 decoding capabilities, the project achieved clear and natural audio output without requiring complex speech synthesis algorithms.

The experimental results confirmed that the DFPlayer Mini efficiently read MP3 files from the Micro SD card and played them with minimal delay. The Serial Monitor outputs verified correct command execution, proper track selection, and stable communication between the modules. The generated speech remained consistent, intelligible, and distortion-free, proving the effectiveness of the preloaded TTS approach for embedded applications.

Key Achievements

- Stable serial communication between Arduino and the DFPlayer Mini for reliable audio playback.
- Successful execution of preloaded MP3 files, triggered by buttons or sensors.
- Clear and natural voice output, suitable for assistive tools, automation alerts, and IoT systems.
- Low-cost and easy-to-build design, ideal for small-scale embedded audio applications.

FUTURE SCOPE

1. **Integration with Real-Time Text-to-Speech Engines:**Future versions can integrate high-performance controllers like ESP32 or Raspberry Pi to support real-time TTS conversion. This will allow the system to generate speech dynamically instead of relying solely on preloaded MP3 files.

2. **Wireless Triggering and Control**:The system can be enhanced with Wi-Fi or Bluetooth functionality, enabling remote triggering of voice messages through smartphone apps, IoT dashboards, or automation networks.

3. **Cloud-Based Audio Updates**:Instead of manually replacing SD card files, cloud synchronization can be introduced to upload or change audio files wirelessly. This allows automatic updates in public announcement systems or IoT devices.

4. **Multi-Language and Customizable Voice Packs**:LThe system can be expanded to support multiple languages or voice variants. Users can select or switch languages via mobile apps, making it suitable for multilingual environments like airports or hospitals.

5. **Integration with Sensors and AI Logic**:By combining the TTS module with sensors (e.g., temperature, gas, motion), the device can deliver intelligent, context-aware voice alerts. AI-based decision-making can further enhance the system's adaptability.

6. **Enhanced Audio Quality and Amplification:**Future designs can include high-power audio amplifiers, noise filters, or better-quality speakers to improve clarity and volume in outdoor or industrial environments.

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