

## DEVELOPING TAJWEED MASTERY USING AI FOR REAL-TIME FEEDBACK WITH ADVANCED AUDIO PROCESSING

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### Article Info

### Abstract

The need to improve Muslims' understanding and application of Tajweed rules served as the driving force behind this effort. The problem statement focused on the absence of an intelligent system that provides real-time feedback on Tajweed recitations, which is a significant challenge faced by learners. A unique approach that combined machine learning and audio processing techniques was used to overcome the issue. The actual challenge was creating the interactive website "TajweedTutor," which enabled users to record their audio recitations of Quranic passages and get immediate feedback on how well they adhered to Tajweed regulations. By extracting and analyzing audio features, machine learning models were trained to recognize specific Tajweed rules and provide instant feedback to users. This approach not only marked a pioneering use of AI in the domain of Tajweed education but also offered a unique interactive learning experience, thereby addressing the specific challenge of real-time feedback in Tajweed learning. The findings indicated that the system effectively recognized and assessed Tajweed rule adherence, improving users' recitation proficiency. This project introduced a transformative tool for Tajweed education, combining tradition with technology to enhance Quranic recitation skills in a user-friendly and accessible manner.

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## INTRODUCTION

The Holy Qur'an is our primary source of law, hence as Muslims, we cannot separate ourselves from its study. Consequently, it is crucial to study the Qur'an from a variety of scientific angles. In terms of reading, mastering and application of recitation are necessary to gain the knowledge in depth and detail. Every Muslim considers it fard ain to read the Qur'an together with its correct recitation (Nurzanah, Rochman, & Maslani, 2019).

The Qur'an means "recitation" in its literal sense. The Qur'an is written in Arabic, and every Arabic letter in the text has a point of origin and specific characteristics. The art and science of reciting the Qur'an is known as tajweed. The existing approaches for retrieving

Quranic domains are mostly focused on matching keywords and do not have sufficient semantic search capabilities (Basharat & Amin, 2021).

According to Yusof, Abdulaziz & Mohamed (2003), the Iqra method may assist with tajweed instruction in elementary schools. In addition to the Iqra system, schools also use techniques like tasmi', group and individual work, drills, tatbiqui, group work, and Musyafahah (MohdIqbal, 2005; Kementerian Pelajaran Malaysia, 2004; Ridhuan, 2000).

When it comes to teaching the Quran, tajweed, or correctly pronouncing the verses, it must be recited with precise and correct tajweed in order to avoid misunderstanding its meaning (Rahman, Kassim, Rahman, & Muji, 2021). The Holy Quran should be accurately recited and learned by Muslims. Yet, conventional methods for recitation verification need human verification, which might not be possible. Conversely, the development of intelligent recitation verification systems based on speech recognition techniques is made easier by Artificial Intelligence (AI) capabilities (Alrumiah & Al-Shargabi, 2022).

Tajweed teaching is typically given one-on-one with a Quranic teacher. While this technique is beneficial, it may not have a systematic system in place for tracking and evaluating students' advancement over time. For learners, there is a lack of an organized way to monitor progress and level of tajweed competency. Without distinct markers of progress, learners might find it difficult to pinpoint areas in which they need to improve, which would eventually hamper their path to mastery.

By using TajweedTutor website, an innovative approach for monitoring users' progress and guiding them Tajweed has been introduced. "TajweedTutor" uses machine learning and sophisticated audio processing to deliver immediate feedback while reciting the Quran. Instant feedback, real-time pronunciation and Tajweed rule assessment, and visual progress tracking are all available to users. With the help of this real-time tracking, users can recognise and correct their mistakes as they occur, providing a dynamic and personalised learning experience.

## LITERATURE REVIEW

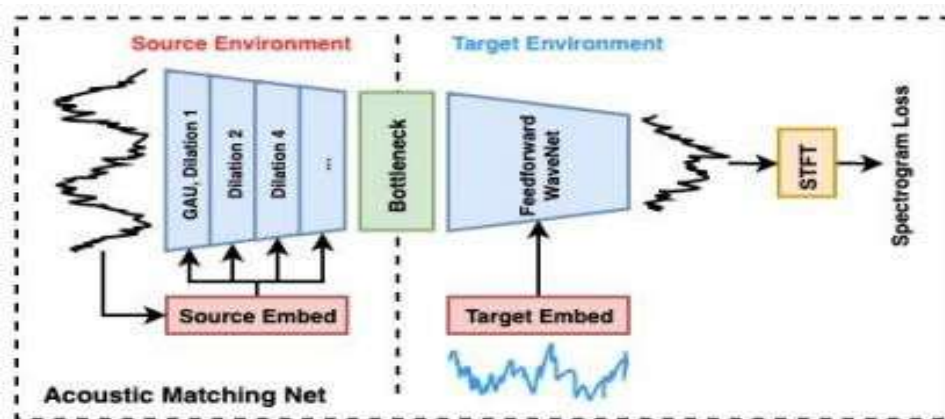
Tajweed is the discipline that contains a set of precise rules for correctly pronouncing letters, along with detailed variations or transformations of sound that relate to the messenger's

approach when reciting the Holy Quran. It is a religious duty that must be performed with great care. Tajweed rules are constructed to guide the reader to utter the Holy Quran text as it was originally uttered by Prophet Muhammad SAW (Dian et al, 2023).

Tajweed, the knowledge of Quranic recitation rules, originated with the first revelation during the early period of Islam. It is inseparable from the Quran itself, indicating the comprehensive nature of Islamic knowledge encompassed within the divine revelation (Sabo, 2019). According to Tajweed, each letter's rights must be respected in order to maintain the correctness of Quranic recitation (Embong, Abdul Hanis et al, 2023).

## Voice Record (Audio Analysis & Audio Fingerprinting)

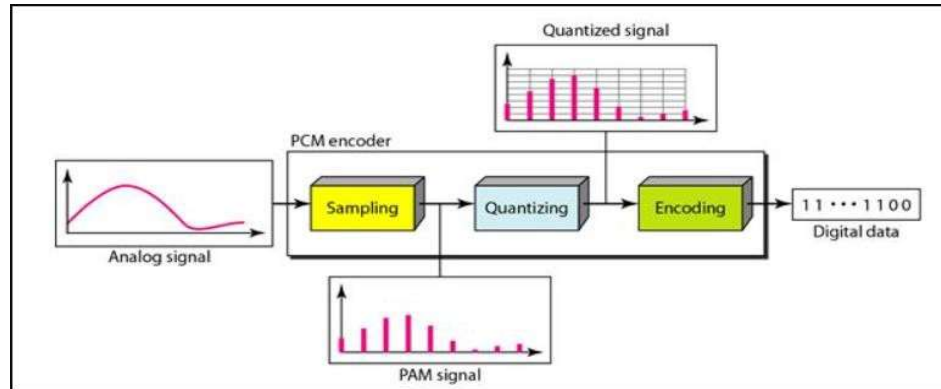
Sound recording and generation refers to the mechanical, electrical, electronic, or computerized engraving and re-production of sound waves, such as those generated when talking, singing, playing an instrument, or sound effects. The two main categories of sound recording innovation are computerized and basic recording. Figure 1 shows the acoustic matching is the process of converting recordings from one environment (the source) to another (the target), with the target environment's samples serving as its key features. Enough similarity between the source and the target is needed for the difference to be undetectable when they are put together (Su, Jiaqi et al, 2020).



**Figure 1** Acoustic Matching Method

(Source; Su J, 2020)

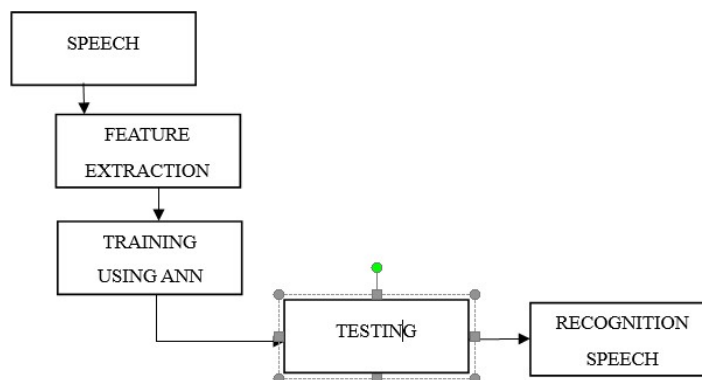
The most significant advancement in recording technology was the switch from analog-to-digital devices as in figure 2. This change was accompanied by a smaller and lighter recorder, longer-lasting batteries, rechargeable batteries, more reliable and capacious storage medium, a wider frequency range, and more easily accessible computer interface.



**Figure 1 Analog-to-Digital Conversion Techniques**

(Sources; Thiru, 2019)

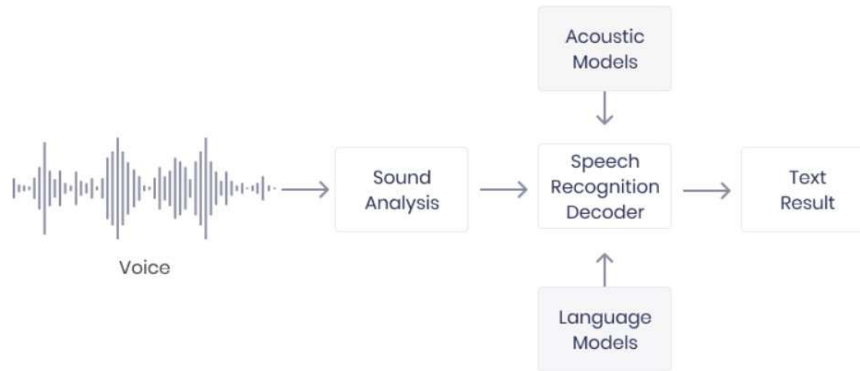
A type of technology called speech recognition enables the user to control an electronic device by spoken word as compared to utilising various devices like buttons, keyboards, and keystrokes, etc. Speech recognition software converts spoken words and phrases into a format that is readable by machines. so that voicing commands to the gadget is simple for the user. Figure 3 displays the speech recognition system's block model. Speech recognition is a rapidly developing field of study with significant applications in learning languages, banking, marketing, healthcare, and many other areas.



**Figure 2 Speech Recognition System**

Originally intended to be a quicker way to type up tasks, voice recognition was created with individuals with mental health issues as well as those experiencing physical challenges can find typing difficult, awful, or even impossible, thus this allows them to continue in the way of talking. You can dictate to your computer using voice recognition software. Upon

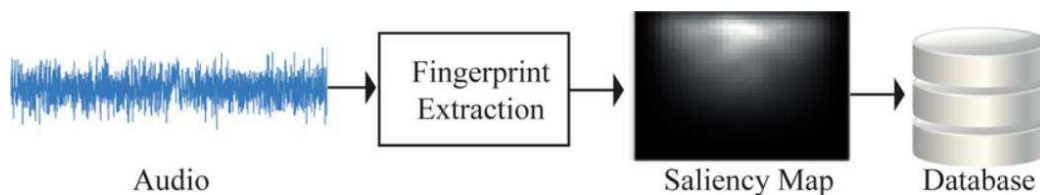
providing instructions via this software, all the instructions will appear on the screen at that same instant as in figure 4.



**Figure 3** Working of Speech Recognition Speech

(Source; Alex S, 2023)

The fingerprint extraction and database search processes are used by the audio fingerprinting algorithm. There are two variations of the search process based on storage. However, the algorithm simultaneously reveals the correlation as a search procedure and the SSM algorithm as a fingerprint extraction technique. The process proposed by is depicted in Figure 5, which combines a fingerprint extraction method based on the saliency maps of the audio signal's spectrogram with a spectrogram representation of the audio signal. Conversely, the audio database's acoustic fingerprint is searched using the correlation function (Algreto, Ignacio et al, 2022).



**Figure 4** General diagram of the SSM algorithm

(Source; Ignacio A, 2022)

### ***Server-side programming language(Laravel & Machine Learning System)***

In server-side programming, scripts are run on the web server in response to information requests made by the user's web browser. These programs are referred to as "back-end"

development since they solely need a web server. To access or input data, the end user communicates with a web server. Dynamic interaction with a database is a typical server-side functioning; end users placing an online order is an example of this.

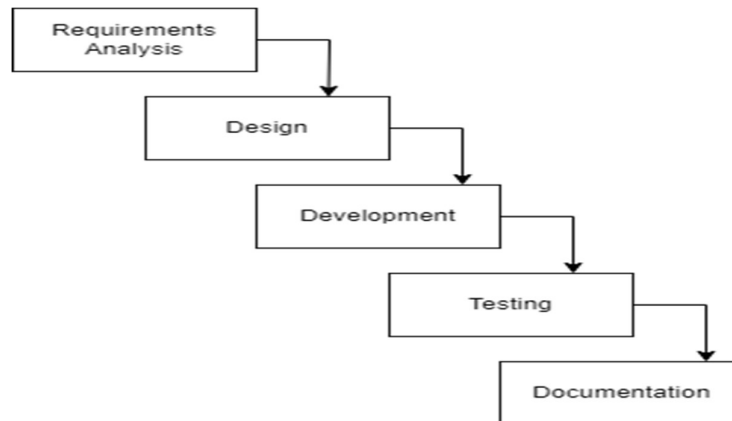
The most popular and widely employed frameworks for development are those for PHP, such as Laravel and Slim, which are used by developers. These frameworks are written in various languages and share a common structure that makes it easier to learn and comprehend. When choosing between these two frameworks, consideration should be given to the benefits each offers as well as how each is specifically implemented. The Laravel framework is ideal for complex enterprise-level applications and for rapidly and effectively enhancing the institution's information network.

Machine Learning (ML) systems process data to identify important patterns that may be used to solve and improve the performance of a particular task. These systems have shown excellent performance and accuracy, driving them to the edge of innovation in a variety of fields and areas, including computer vision, autonomous transportation, health care, biomedicine, and law. ML systems must be transparent and fair, for example, free of bias in decision-making and capable of protecting the data of the various parties involved, primarily data owners and model users (El Mestari, Soumia Zohra et al, 2023).

## METHODOLOGY

This chapter will cover the additional methodology study that has been done for the project. To complete this project research, a variety of methodologies and procedures are required, which are included in the methodology. The project's objective, scope, and process flow were explained, with a particular focus on methods and techniques that could be applied to gain a better understanding of the project.

This project will be developed in phases based on the waterfall model. In other words, the phase chosen will serve as the instructions for ensuring that this project will be constructed correctly and operates as expected. Figure 6 below shows the phase that will be used and table 1 shows the process on each phases.



**Figure 6** Modified Waterfall Model

**Table 1** Process on each phase

Phase	Activity
Requirement Analysis	<ul style="list-style-type: none"> <li>- Conduct an analysis</li> <li>- Identify the software and hardware use</li> <li>- Identify and study the technique that been use</li> <li>- Focus on the comparison of the related review</li> <li>-Design Use Case Diagram (UCD)</li> </ul>
Design	<ul style="list-style-type: none"> <li>- Designing activity diagram</li> <li>- Entity Relationship Design (ERD)</li> <li>- User interfaces</li> </ul>
Development	<ul style="list-style-type: none"> <li>- Develop web module</li> <li>- Apply technique</li> </ul>
Testing	<ul style="list-style-type: none"> <li>- Conduct a functionality test</li> </ul>
Documentation	<ul style="list-style-type: none"> <li>- Compile all report</li> </ul>

## RESULT AND FINDING

Functionality testing examines that the application performs as expected and meets the specifications. It validates the data flow for creating, reading, updating, and deleting actions, as well as the system's logic and rules. Sir Mohammad Hafidz bin Rahmat examined the functionality of the TajweedTutor system. The modules that were tested included User Registration, Login, Profile Management, Audio Recording, and Real-Time Feedback. Table 2 below shows the functionality test case.

**Table 2** Functionality test case

Test case ID	Test Case Description	Expected Result	Pass / fail	Actual Result
FT1	User registers an account	Account registered and redirected to Login Page	Pass	-
FT2	User logs in	Redirected to Home Page	Pass	-
FT3	User updates profile	Profile updated successfully	Pass	-
FT4	User records recitation	Audio recorded and processed	Pass	-
FT5	System provides real-time feedback	Feedback displayed on screen	Pass	-



## CONCLUSION

In conclusion, the TajweedTutor system has shown considerable potential as an innovative platform for enhancing Quranic recitation skills. It overcomes the limits of traditional Tajweed learning methods by providing real-time feedback and utilizing powerful AI techniques, making it a vital tool for learners globally. The positive findings of the functionality testing show that the system works as intended and achieves its key goals, which are to improve accessibility and efficacy in Tajweed learning. The deployment of this technology has the potential to considerably benefit the Islamic education sector by offering an effective and user-friendly platform for practicing Quranic recitation.

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