YorCALL: Improving and sustaining Yoruba Language through a practical Iterative learning Approach

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ABSTRACT
The number of people who speak Yoruba language fluently and write it correctly with appropriate tonal signs is declining. This could be attributed to the adoption of English Language (a colonial language) by parent as their children first language and the neglect of Yoruba from most Nigeria Educational system curricula. To this end, the aim of this work was to improve user knowledge of tonal sign assigning, correct word pronunciation and thus Yoruba language literacy by implementing a Computer Assisted Language Learning System that translates Yoruba text to speech, and allows users to check-up the meaning of words and take test on Yoruba language literacy. We propose a practical iterative learning approach that factors in the basic features and requirements that will ensure the optimal realization of benefits of the system to the user.

CCS Concepts
• Computing methodologies →Artificial intelligence →Natural language processing →Machine translation

Keywords
Tonal, Speech, Dataset, Iterative, Translate

1. INTRODUCTION
Yoruba tribe makes up about 35 million people in total with majority constituent from Nigeria (about 21% of Nigeria's population), 1.2 million in Benin, 0.4 million in Ghana, 0.1 million in Togo)0.1 million in Ivory Coast, 0.2 million in Europe and 0.2 million in North America [15]. Yoruba language is a tonal language consisting of seven vowel sounds exclusive of nasal vowels and eighteen consonant sounds, making up 25 alphabets and 3 tonal signs (three level tones: high, low and mid (the default tone) to distinguish between words with the same spelling but different pronunciation and meaning. Every Yoruba syllable must have at least one tone.

There is a continued decline in the number of "Yorubas" that can speak Yoruba language fluently and write it correctly with appropriate tonal signs. This is as a result of adoption of English Language (a colonial language) by parent as their children first language and the neglect of Yoruba from most Nigeria Educational system curricula.

To prevent extinction of Nigeria's indigenous languages there have being persistent calls by various esteemed scholars and organisation to revive Nigeria indigenous languages, by adopting Indigenous languages as Children's first language and making Indigenous languages a compulsory course to be taken by students in all level of education. However, there is need for more efforts that will adopt practical approach to ensure that the language remains intact. To this end, Computer Assisted Language Learning (CALL) for Yoruba is developed in this project to help speakers of Yoruba language to speak correctly and fluently by applying the appropriate tone on words they pronounce.

CALL is perceived as an approach to language teaching and learning in which the computer is used as an aid to the presentation, reinforcement and assessment of material to be learned, usually including a substantial interactive element [4].

The computer is used to ameliorate users' knowledge of particular Language/languages. CALL has being continually adopted as medium of learning new languages or improving on old ones. Over the years CALL is used to incite language learners, provide comfortable access to learning material, testing of users acquisition level and examining the relevance of call to Learning and Disseminating System (Checking if it has accomplish its functions and purpose).

The CALL system provided information which is expected to be responded to by system users. The system in turn process input and gives appropriate justification of input structure and meaning.

To improve Flexibility of Computer Assisted Language Learning Interaction between system and users have being adopted, text, static and moving images and audio are used for interactive Computer Assisted Learning Language System Environment.

By adopting a practical iterative learning approach, this work focuses on improving user knowledge of Yoruba tonal sign assigning, correct word pronunciation. It also improves Yoruba language literacy by implementing a Computer Assisted Language Learning System that translates Yoruba text to speech, and allows users to check-up the meaning of words and undertake test on Yoruba language literacy.

2. BACKGROUND
Previous studies have focused on CALL by identifying three historical phases of CALL and classified them according to underlying pedagogical and methodological approaches [10]. The participation of the potential users of the system in CALL development cannot be sidelined, which is "the active involvement of end-users, as non professional developers, in a software development life cycle[5]. The contribution of language learners tutoring system improves the effectiveness of the system design. The CALL system developers should be focused on getting right requirements and intelligibly transforming it to a standardised design.

2.1 RELATED WORKS
An Intelligent CALL System for Arabic Learners was designed for Primary Schools and Arabic language learners. The system

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employed Natural Language Processing for learning the language and provides learning materials for the users, on which they are expected to take test on. The instructor is able to stipulate conditions to determine the test questions specialisation. The response given by users is analysed using morphological analyser, syntax analyser and semantic analyser. The morphological analyser breaks down response of the users to smallest component of the language. The syntax analyser checks for the structural correctness of user's response and form syntactic categories. The Semantic analyser checks for rule based approach to generate appropriate response to result given by the system users to promote effective learning. [8]
RU_CALL, a standalone system is aimed to provide electronic language acquisition domain for learning and improving knowledge of users with at least the basic/passive noesis of Runyakitara language. The system centred on nominal morphology, morphological analyser was used to develop exercises for learning. The system focused on nouns and made use of natural language processing to create extensive lesson materials for prospective users of the system. Runyakitara Computer Assisted Language Learning was created as a screening tool for users, to test the users syntactic and semantic knowledge of the language, serve as access tool for learners and give relevant activity for learners. The system accomplished its intended goal with large percentage of users showing continual interest in RU_CALL. [14]

There is Computer Assisted Language Learning system which consists of comprehensive wordbook consisting of Root language (English) to Object language (Yoruba) [1]. The Language Assistance System identifies words separated by space which is converted to source text by lexical transfer and attaching appropriate part of speech. The acceptable structure was achieved by matching twenty-eight corresponding English Noun Phrase rules with corresponding Yoruba arrangement of the rule.
Data fed into the system (in English) is pre-processed and translated to corresponding data in Yoruba language. The input is checked for its correctness using existing information in the database. A system with about 90 percent exactitude was produced and regarded as auspicious and satisfactory.

The principles of Natural Language Processing and Digital Signal Processing was adopted to develop a CALL system [13]. Natural Language Processing does the breakdown of sentences into syllables, which is the smallest unit of the sentence (vowel, consonant: nasal and non-nasal) by emphasizing on tones of the syllables. Digital Signal Processing consists of speech processing and sound processing. Speech processing checks for syllables corresponding to input block of text and combine together to form strings and then optimizing them. The sound processing (Speech signal) process the sound and make the pronunciation sound available.
A web based Computer Assistance Language Learning on two languages was built, to translate from Yoruba phrases to English Language and contra wise [14]. Poly-layer framework and Hidden Markov Model were employed. Using mathematical and word principle, Yoruba and English words were grouped into two exclusive sets. The set theory was used to determine acceptable structure, axiom of extension, for any two subsets from source and target languages to be equal there must be like components. The law of probability, Bayes' theorem, and Statistical design theory were used to increase the CALL system accuracy and produce result.

2.2 Yoruba Phonemics

Yoruba language is a tonal language consisting of seven oral vowel sounds, five nasal vowels and eighteen consonant sounds and 3 tonal signs (three level tones: high, low and mid (the default tone) to distinguish between words with the same spelling but different pronunciation and meaning. Every Yoruba syllable must have at least one tone.

Consonant Sounds
b, d, f, g, gb, j, k, l, m, n, p, r, s, ṣ, t, u, w, y

Vowel Sounds
Oral vowel: a e ẹ i o ọ u
Nasal vowel: an ẹn in ọn un

3. SYSTEM MODEL

The framework of Yoruba Computer Assisted Language Learning (YorCALL), as shown in figure 1, presents the different components and their interactions. Sectionalized into three, the framework can be viewed as:

- Front end Interactive interface (YorCALL Interface)
- Modules (Palindrome, Class, Game, Learn & Dictionary) and
- Back end (YorCALL Database)

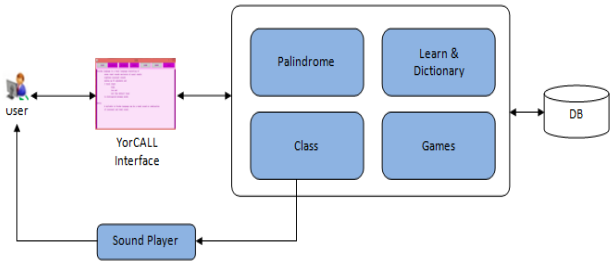

Figure 1: YorCALL Architectural Framework

The YorCALL interactive interface provides the user with an interface to enter any Yoruba text with the use of on-Screen keyboard or the provided buttons with Yoruba alphabets and sign. The YorCALL Database mainly consist all the Yoruba syllable sounds as recorded by a Yoruba Language expert from Oyo town. The Learn & Dictionary modules provide the users with basic knowledge on the meaning of most common Yoruba words such as cardinal and ordinal numbers from one to ten and days of the week and months of the year as well as English words listed in alphabetical order from A-Z with information about them. It consists of 1000 English words and their equivalent in Yoruba language. Users are able to hear the corresponding pronunciation of the words. The Palindrome module responds to indicate whether any Yoruba word as entered by the user is/is not a palindrome.

3.1 Class Module

The CLASS module provides principles of pronouncing words in Yoruba language and also provides guide on the principle of tonal signs and applications. It allows the user to write down words, check for validity and pronounce the word for the user.

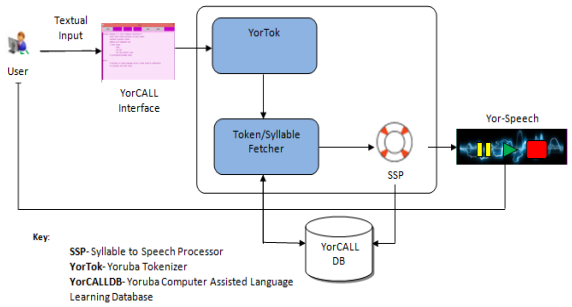

Figure 2: Model of the Class Module

As depicted in figure 2, YorCALL system's processes include:

a) breaking words into syllable
b) fetching the audio equivalent of syllable
c) stacking and concatenating sounds to produce a word sound

Users are can type in words for pronunciation by using the onscreen keyboard provided or use any keyboard that allows user to type Yoruba fonts. The words are broken down to syllable(s) and equivalent audio sound of the syllable is fetched and concatenated. After which a sound player box pops up and users are able to play the sound.

3.1.1 Tokenizer

A syllable in Yoruba can either be a vowel sound, combination of vowel and consonant, or nasal sound. During the process of breaking words down to syllables, the tonal sounds assigned by the user is taken into consideration. Each word input by the user is scanned through, vowel letters are the main unit is used for tokenisation.

The tokenization process is broadly divided in three phases, namely:

i. accept word
ii. scan from the left, check for vowel sounds
ii. anywhere there is a vowel sound break, and then add to syllable set until end of the word.

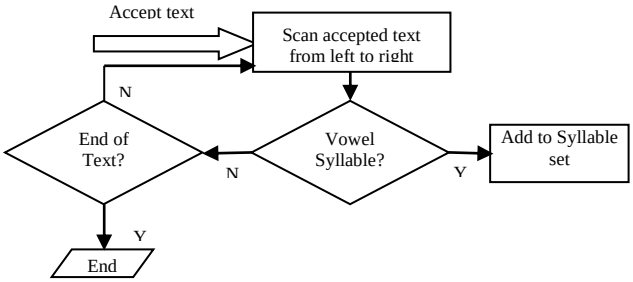

Figure 3: Flow Diagram of the tokenization process

For Illustration, if b is to be combined with the vowel sounds; it will produce the following syllables as in table 1:

Table 1: Some Yoruba Syllables

Consonant Alphabet	Vowel Sounds	Syllables Produced
b	a e ẹ i o ọ u á é ẹ́ í ó ọ́ ú à è ẹ̀ ì ọ̀ ò ù an ẹn in ọn un án ẹ́n ín ọ́n ún àn ẹ̀n ìn ọ̀n ùn	ba be bẹ bi bo bọ bu bá bé bẹ́ bí bó bọ́ bú bà bè bẹ̀ bì bọ̀ bò bù ban bẹn bin bọn bun bán bẹ́n bín bọ́n bún bàn bẹ̀n bìn bọ̀n bùn
⋮	⋮	⋮

3.1.2 Token/Syllable Fetcher

Each of the vowel sounds was combined with each consonant and nasal sound to generate all possible syllable. These sounds to each syllable were recorded using audio recorder by a Yoruba language speaking expert. The recorded sounds were subsequently trimmed to eliminate noise and saved in the YorCALL DB with the file name they represent. The Token/syllable fetchers searches through for the coreesponding audio sound for each token for stacking and concatenation.

3.1.3 Syllable to Speech Processor

After successful process of tokenisation and equivalent audio sound of the syllables are fetched from the audio dataset, they are stacked in the order of their entry (from left to right) and concatenated, ready to be played by the sound player box. Users are able to view the breakdown of words pronunced to syllable and play the sound equivalent as often time as possible as shown in Figure 6.

SS_1 + SS_2 + SS_3 …+… SS_n

Where SS represents syllable sound

3.2 System Class Diagram

YorCALL has five classes (Class, Palindrome, Dictionary, Learn, Games) which are subclasses of the Home. The Sound Player is a sub class of the Class with a modal dependency. As shown in Figure 4, each class has at least member methods with data member ranging from zero to six.

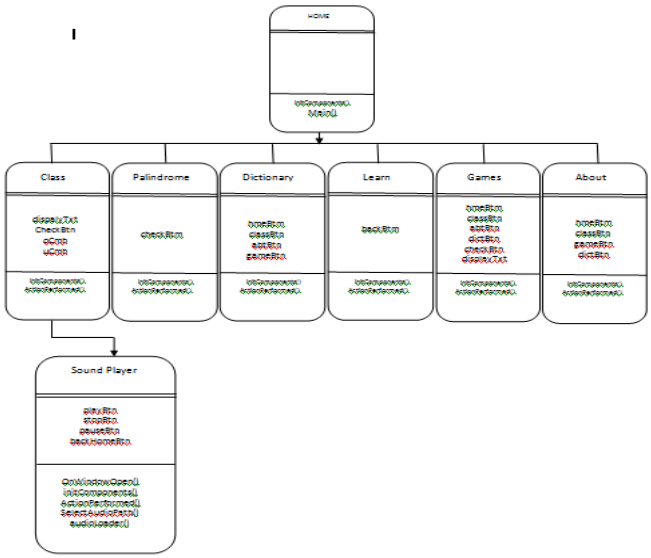

Figure 4: YorCALL Class Diagram

4. SAMPLE SCREEN SHOTS OF YORCALL

The user enters a yoruba text with the customized keyboard provided as shown in Figure 2 which allows the entering of any Yoruba word. On clicking the 'check' button, the tokenize() method is called and the inputted text is syllabilized.

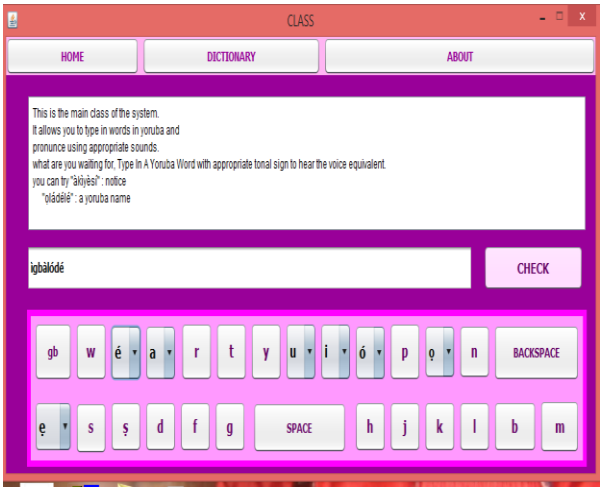

Figure 5: The Text Input Screen

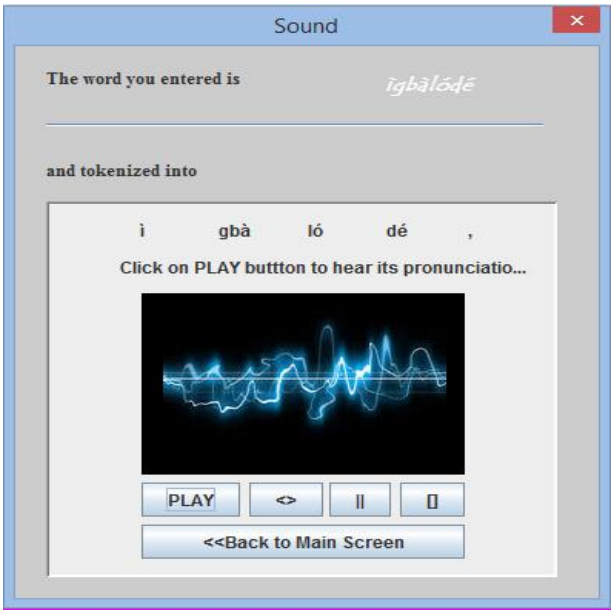

Figure 6: The Sound Screen

5 PERFORMANCE MEASURE OF THE SYSTEM

Three category of users (amateur speakers, average Yoruba speakers, above average speakers) yielded the following summarized responses as observed in Table 2:

Table 2: Summary of Responses to Administered Questionnaire (Source: [13])

	Weight	5	4	3	2	1
	Questions	VH	H	F	L	VL
X4	How would you rate the performance of the developed YorCALL system?		19	30		
X5	How would you rate the use of this application?	6	26	16	1	
X6	How would you rate the voice quality produced by the developed system?	6	26	13	6	
X7	How would you rate the sign assignment of the Yoruba alphabets display on the screen?	27	13	7	12	
X8	What is your rating of the naturalness of the output from the developed YorCALL?	9	19	14	7	
X9	What is your overall performance assessment of the developed YorCALL?	6	27	13	3	
		SA	A	N	D	SD
X10	Would you agree that the sound produced by the developed YORCALL was close to Natural human voice?	10	24	12		
X11	Would you agree that the response time (i.e. time duration for producing sound) was of no significance?	17	23	9		
X12	Would you agree that the developed YorCALL system is reliable to convert Yoruba text to spoken expression?	16	24	9		
X13	Would you agree that the developed YorCALL can serve as a teaching aid for Yoruba language?	15	14	7		
X14	Would you agree that the developed system will be of help to a visually challenged person?		11	25	13	

Key:
SA-Strongly Agree, A-Agree, N-Neutral, D-Disagree, SD-Strongly Disagree
VH-Very High, H-High, F-Fair, L-Low, VL-Very Low

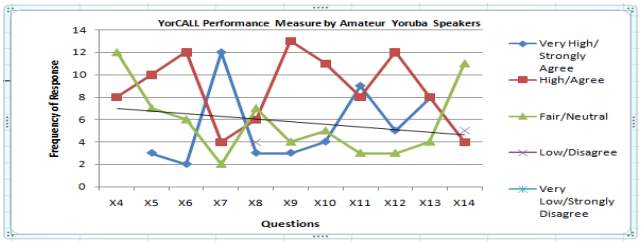

Figure 7: YorCALL Performance Measure by Amateur Yoruba Speakers

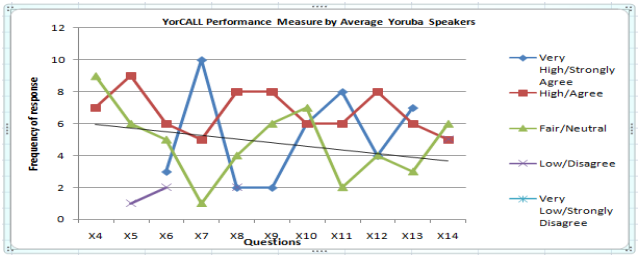

Figure 8: YorCALL Performance Measure by Average Yoruba Speakers

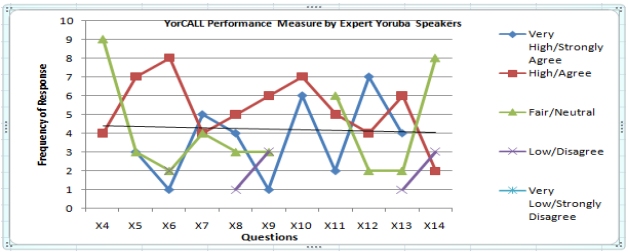

Figure 9: YorCALL Performance Measure by Expert Yoruba Speakers

The reponses of the three categories of users/Yoruba speakers (amateur, average and expert) as shown by in Figures 7, 8 and 9, reveal, at both extremes, about 75% acceptability and usability of the system but only 20% voted for it to be used by the visually challenged persons. Based on the feedback in X7,X8, X10, about 80% agreed that the naturalness of the system produced sound was like that of Yoruba natural speaker. 70% of the respondents agreed that the system can be used to not only improve the language tonal sign assigning but also the language literacy.

6. CONCLUSION

The study has presented a CALL system for Yoruba language with the main objective of providing a digital learning environment that introduce Yoruba language to new learner or improve amateur's knowledge, especially in the area of correct word pronunciation and right sign assigning. Using personal computer, the system enables the user to learn at his/her own time and place. Future work is ongoing to expand the number of words in the dictionary and improve on present functionalities of the system such as development of game whereby the system pronounce Yoruba words randomly and the user provides the textual equivalence, considering the tone, wherby the user input is validated. In conclusion we believe the system can be further scaled to include other threatened languages and taught in various levels of Institutions of learning.

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