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QEFSM model and Markov Algorithm for translating Quran reciting rules into Braille code

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Abstract The Holy Quran is the central religious verbal text of Islam. Muslims are expected to read, understand, and apply the teachings of the Holy Quran. The Holy Quran was translated to Braille code as a normal Arabic text without having its reciting rules included. It is obvious that the users of this transliteration will not be able to recite the Quran the right way. Through this work, Quran Braille Translator (QBT) presents a specific translator to translate Quran verses and their reciting rules into the Braille code. Quran Extended Finite State Machine (QEFSM) model is proposed through this study as it is able to detect the Quran reciting rules (QRR) from the Quran text. Basis path testing was used to evaluate the inner work for the model by checking all the test cases for the model. Markov Algorithm (MA) was used for translating the detected QRR and Quran text into the matched Braille code. The data entries for QBT are Arabic letters and diacritics. The outputs of this study are seen in the double lines of Braille symbols; the first line is the proposed Quran reciting rules and the second line is for the Quran scripts.

1. Introduction

With the rapid growth of the technology over recent years, the way people interact with the outside world has changed and the gap between disabled and normal people has reduced. Lately, according to the World Health Organization (WHO), there are around 314 million people who live with visual impairment and 90% of them live in low level countries (WHO, 2014). Braille is a system of writing that uses patterns of raised dots to inscribe characters on paper. The original military code was twelve dot cells that were represented at six rows and two columns of dots called the night writing code, and it was used after dark as a communication way between the soldiers where the dot or relational dots represent a character, sound or a specific sign (Yamuna and Vora, 2013). Louis Braille improved the code and made the code easy and fast to read, where the soldiers were facing the difficulty reading the letters and signs that were represented by the twelve dots (Mellor, 2006). The six Louis dots were easier than the twelve military dots where it could be felt by the fingertips, and the new code had been accepted as a universal

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communication way between the blinds and the world around them, and as it has been translated for most languages, it becomes the World's blind language. As shown in Fig. 1; the Braille cell consists of six (6) dots arranged in the formation of a rectangle; three (3) down, two (2) across. Each Braille cell or symbol represents scientific characters, mathematical symbols, punctuations in music, and computer notations.

Previously in Abualkishik and Omar (2009a), we propose Braille symbols for Quran reciting rules in order to give the visual impaired people a chance to recite the Holy Quran correctly. The current work continues the previous work in Abualkishik and Omar (2009a) by proposing a Quran Extended Finite State Machine (QEFSM) model to detect all the reciting rules as found in the Quran text. Look-up table indexes QEFSM model states and decision table control the transaction function for the model. The outputs of the QEFSM model are sent to the Markov Algorithm for the translating process. Also, a Quran Braille Translator (QBT) is proposed to evaluate the QEFSM model work. The translated Braille code is printed out into a new proposed printed method. Each Quran line is translated into two Braille lines, the first Braille line represents Quran reciting rules' Braille symbols and the second line represents letters and diacritics Braille symbols.

2. Related works

Recently, technology explosion has had a positive effect on the increase of the human perception, especially for the third and second world countries. The Braille system is one of the systems that are important to the humanity. Braille gives a lot of young blind people the opportunity to participate in the scientific growth and automatically making them effective members in this world; but the blindness limited their ability. The Arabic language was translated to Braille code in Roy (2000) and Sensus, 1999. However, there is no specific system or research done with regard to the area of the Quran in Braille, and usually Braille Quran is printed out by unsystematic methods such as Perkins Braillewriter and Slate and Stylus. The learning of Quran reciting rules is an obligation for each Quran reader, where the need to learn and apply Quran reciting rules tends to affect the meaning of Holy Quran verses and causes change in the purpose of the verses. Al-Quran is GOD's Holy Book, and the correct understanding of the Quran text is imperative for all Muslims, including those who are disabled.

In King (2000), Alksander King concerns with translating the text to and from Braille (not handle the Arabic language), by using the matching of left and right contexts of the translation windows, with the finite state machine. The Finite state machine technique was used to handle the grades of Braille within the same language and to allow a single set of rules to assume the role as translation to and from Braille for a language. The decision table controls the operation of the finite state machine, and makes a simple list of character translation rules that can be edited directly by non-technical users. The UMIST translation system (Blenkhorn, 1997) is one of the few published works on text and Braille translation in recent years. Where the engine state is controlled by a finite state machine, the contents of the decision table are used, and which subset of the language translation rules to be used is regulated. The translation engine can use any language rule table, so any language can be translated to or from the Braille code if the language rule table is constructed.

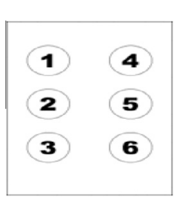

Figure 1 Braille cell (symbol).

3. Quran reciting rules

The Holy Quran was translated in many languages, but the original text was revealed to the Prophet in the Arabic language, (Malik, 2007). At Babker (1983) & Al-kari' (1998); There are around 21 reciting styles for the Holy Quran verses, but the most widespread reciting style in the Islamic world is Huff's reciting style. Quran reciting rules (QRR) are a set of rules that must be applied through Quran reciting. These rules change the pronunciation sound for Arabic language letters (Abualkishik & Omar, 2009b). This work is concerned with five main types of QRR: that are Noon Sakenah, Meem Sakenah, Lam Sakenah, Scoon (Kalkala) and Mudd (Prolong). These five main types are divided into thirteen subtypes.

As shown above in Fig. 2, there is a need for thirteen Braille symbols to represent the previous QRR but in order to prevent any conflict and to decrease the number of the new adopted symbols, six Braille symbols had been adopted to represent the thirteen Quran reciting rules. (The numbers inside the circles represent the number of rules set for each QRR, and there are one hundred twenty rules.) The reciting rules denote the pronouncing state for the letters which means that the same state (reciting rule) could apply to different letters, for instance see these two examples in Table 1.

The thirteen (13) QRRs' pronunciations could be classified into six (6) QRRs that are Edhar (Adhere), Edgham (Diphthong), Ekhfa' (Conceal), three types of Mudd (Prolong) and Kalkala. Through this study; five reciting rules are represented by one Braille symbol and one reciting rule (Mudd) is represented by two Braille symbols; first one for Mudd and the second for the prolong space. These symbols were proposed in Abualkishik and Omar (2009a) (see Table 2).

4. Quran Extended Finite State Machine (QEFSM) model

In Beesley and Karttunen (2002); the finite state machine (FSM) is the most suitable technique for linguistic and Natural Language Processing (NLP) applications. FSM is modularity (FSM is supporting and combining a variety of operations and relations gather), clear representation (FSM is implementing the rules directly and in a straightforward manner, so it is easy to understand and modify), efficiency (FSM is a deterministic technique that is almost non mysterious and gives a positive effect to improve time efficiency) and compactness (FSM can be minimized at the same time improving the storage requirement, time efficiency and the probability