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# From Arabic Alphabets to Two Dimension Shapes in Kufic Calligraphy Style Using Grid Board Catalog

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**Abstract:** The Kufic font takes its name from the location in which the font was created around the end of the seventh century, Kufa, Iraq. Kufic was the principal script used to replicate the Qur'ans until approximately the eleventh century. Depending upon where a character is located in a word, the character may be represented differently. Given this location-specific representation, the Arabic characters uses in script are expanded to 116 shapes. A character can have an isolated shape, a joined shape, a left joined shape and a right joined shape.

The goal of this study is to convert Arabic script to a two-dimensional shape in Kufic calligraphy style that has regular geometric components (lines, circles, curves, arcs, etc.) by using a grid board catalog. The converting process represents a method of learning electronically as well as production for all Arabic alphabets in aesthetic shapes. The proposed grid board produces all possible shapes of any letter in Arabic alphabets. Some alphabets are shared by sub shapes and are overlapped in the grid board in order to visualize them as groups of similar characters. The position of a letter in the grid board, the letter dimension itself (width and height) and the position of letters in Arabic words were required to convert the characters. The results showed that the proposed grid is a powerful and influential tool that can be used to learn the Kufic font style with a simple, easy and effective method when contrasted to the classical method.

**Keywords:** Arabic Scripts, Grid board catalog, Kufic font, Shapes of characters.

## 1. Introduction

Art in Islam follows the tradition of being non-representational, especially in important circumstances such as in the mosque, writing and illumination. The strict style gives it special appeal, being non-individualistic and not influenced by scale. In writing, Square Kufic is the essence of the sparse nomadic tradition in its abstract stylized form such as that of the traditional archaic Kufic script.

Calligraphy, from the Greek word kalligraphía (καλλος kallos "beauty" + γραφος graphos "writing"), is significant. Indeed, delightful written work assumes an essential part in Islam. Calligraphy has been perhaps the main expression of representational art in Islam, as the Islamic convention has regularly scowled upon any allegorical symbolism [2].

One of the earliest scripts is the Kufic or Kufi script, which is thought to have started in the city of Hira. This rakish script utilizes strong, short strokes for every letter. There is a squarish part to every letter as well. In original copies, the letters regularly appeared as strong dark characters while the diacritical markings, often red, were a differentiating character. Because of its thickness, it was frequently used as a part of stone carvings and in structural engineering and on different coins. For 300 years, it was the essential script utilized as a part of replication of the Qur'an and is still being used today. There are different types of Kufic script, named for the city it originated in. Types of Kufic script include foliated, plaited, and Qarmatian Kufic [3][4]. The fundamental for this script is that it is precise and squarish. Besides the three primary types of Kufic script, there are two further variants, Maghribi and Andalusi. These two variations in the script still hold the precise attributes; but is more flexible and includes more curves [2].

In this paper, an efficient method is proposed to produce Arabic alphabets in Kufic font using a grid board catalog, which is regarded as a good tool for learning "How to write in Kufic font", especially that the Kufic calligraphy style has regular geometric components (lines, circles, curves, arcs, etc.) which can be overlapped and generated

easily by a grid board catalog. The production process involves converting Arabic script to two-dimension shapes, depending upon their location within the word.

The organization of this paper is: Section 2 introduces related works; Arabic script features are explained in the Section 3 materials and methods are presented in Section 4; experimental results can be found in Section 5. Finally, conclusions are provided in Section 6.

## 2. Related Works

Ilham Chaker (Ilham Chaker, et al., 2011) proposed a procedure for creating Moroccan fonts from manuscripts that are characterized and known by their artistic values. It is initially a question of choosing the manuscript that has a good artistic representation of the characters. Once identified the manuscript is scanned to determine the segmentation and extract the characters. A factorization of the extracted characters can then be used to generate the actual font [5].

Sherif Mansour and Hossam Fahmy (Sherif Mansour and Hossam Fahmy, 2012) attempt to use a new font, AlQalam, for the Arabic script within TEX, and introduced new features to achieve a complete functional font package. They describe how to use a new right to left font within TEX, as well as the approaches to debug the font [6].

## 3. Arab Script

### 3.1 *Features*

Each spoken language has its own elements that are connected in perusing, composition, listening and talking. Arabic language is a root-based dialect comprised of 28 letters with each letter having vowels that vary according to the diacritics utilized. Portions of the 28 letters are composed with various shapes depending on their position in the word [7].

Arabic segment in the Hex reference of the Unicode institutionalization that incorporate

characters, for example, letters, images and diacritics ranges from 0600 to 06FF. The Arabic letters in Unicode range from 0621 to 063A and from 0641 to 064A [9]. The features of Arabic scripts are explained in table 1 [8].

3.2 *Glyphs*

The Arabic letters regularly take different structures, depending on where the letter falls in the word and the text style that is utilized. The state of letters in Kufic text style is not the same as letters in the Nasikh textual style. Most letters have a starting structure (beginning of a word), center structure (center of a word), completion structure (finishing a word), and stand-alone shape. The arrangement of glyphs totals 116: 22 letters have four option shapes, and 6 letters have two option shapes (See Table 2). Large portions of the structures associate with the past letter (if there is one) and also interact with the accompanying letter (once more, if there is one). Nonetheless, there are six letters which are non-connectors, implying that they don't unite with the letter that follows. These six letters are ALEF, DAL, THAL, RAH, ZAIN, and WAW [10].

This paper will explain the glyphs of letters in Kufic font, to facilitate the learning process of writing in this font. In this paper, three Arabic calligraphers (Abdel-Kareem AL-Shammari, Jamal AL-Kabbasi, and Mohammad Abdel-Qader) were considered in generating and learning Kufic fonts. For example, the letter FEH has four glyphs explained in Figure 1.

Table 1. Features of Arabic scripts

| | |
|---|---|
| **Features** | **Notes** |
| Script name | Abjad |
| Case distinction (sensitive) | No |
| Multiple combining Characters | Yes, diacritics for vowel sounds are typically not used. The Shadda (like diacritic, that doubles the consonant value) is often not used either. But if they are used together, they have to be displayed together above the same base consonant. |
| Context-based Positioning | Yes, for example the diacritic being placed at different heights, depending on the height of the base character that it appears above. |
| Contextual shaping | Yes, This example is font dependent. In more classical fonts, you will often see the join between certain characters above the baseline, rather than at the baseline. Certain letters in the highlighted sequence may join above the line, or on the baseline, |
| Cursive script | Yes, Arabic script joins letters together. |
| Many more glyphs than characters? | Since Arabic is a cursive script, there are many more glyphs in a font set than there are characters, since you need glyphs that join in various ways. Not only that, but Arabic also has ligatures, which themselves join to characters or other ligatures alongside them. One ligature (lam-alif) is mandatory. |
| Text direction | Arabic script is written right-to-left |
| Baseline | Mid |
| Space is word separator | Yes |
| Wraps at | Word |
| Justification | The Arabic justifies text by stretching the baseline and the glyphs of the text, rather than expanding inter-word spaces. Justification can also introduce ligatures in order to squeeze more text onto a line. |
| Native digits? | Yes |
| Other | glyph height; glyph width variation |

| Isolated | Final | Medial | Initial |
|---|---|---|---|
|  |  |  |  |

Figure1. Shapes of FEH Arabic letter

**4. Methodology**

In this paper, a new method is presented to generate Arabic scripts using a grid board for drawing the glyph of character in Kufic font. The process begins by inputting any Arabic word and then producing it in Kufic calligraphy style with the following components (See Figure 2).

Table2. Arabic alphabets

| Name | Unicode | Shapes | | | |
|---|---|---|---|---|---|
| | | Isolated | Final | Medial | Initial |
| HAMZA | 0621 | ء | | | |
| ALEF WITH MADDA ABOVE | 0622 | آ | ـآ | | |
| ALEF WITH HAMZA ABOVE | 0623 | أ | ـأ | | |
| WAW WITH HAMZA ABOVE | 0624 | ؤ | ـؤ | | |
| ALEF WITH HAMZA BELOW | 0625 | إ | | | |
| YEH WITH HAMZA ABOVE | 0626 | ئ | ـئ | ـئـ | ئـ |
| ALEF | 0627 | ا | ـا | | |
| BEH | 0628 | ب | ـب | ـبـ | بـ |
| TEH MERBUTA | 0629 | ة | ـة | | |
| THE | 062A | ت | ـت | ـتـ | تـ |
| THEH | 062B | ث | ـث | ـثـ | ثـ |
| JEEM | 062C | ج | ـج | ـجـ | جـ |
| HAH | 062D | ح | ـح | ـحـ | حـ |
| KHAH | 062E | خ | ـخ | ـخـ | خـ |
| DAL | 062F | د | ـد | | |
| THAL | 0630 | ذ | ـذ | | |
| RAH | 0631 | ر | ـر | | |
| ZAIN | 0632 | ز | ـز | | |
| SEEN | 0633 | س | ـس | ـسـ | سـ |
| SHEEN | 0634 | ش | ـش | ـشـ | شـ |
| SAD | 0635 | ص | ـص | ـصـ | صـ |
| DHAD | 0636 | ض | ـض | ـضـ | ضـ |
| TAH | 0637 | ط | ـط | ـطـ | طـ |
| ZAH | 0638 | ظ | ـظ | ـظـ | ظـ |
| AIN | 0639 | ع | ـع | ـعـ | عـ |
| GHAIN | 063A | غ | ـغ | ـغـ | غـ |
| FEH | 0641 | ف | ـف | ـفـ | فـ |
| QAF | 0642 | ق | ـق | ـقـ | قـ |
| KAF | 0643 | ك | ـك | ـكـ | كـ |
| LAM | 0644 | ل | ـل | ـلـ | لـ |
| MEEM | 0645 | م | ـم | ـمـ | مـ |
| NOON | 0646 | ن | ـن | ـنـ | نـ |
| HEH | 0647 | ه | ـه | ـهـ | هـ |
| WAW | 0648 | و | ـو | | |
| ALEF MAKSOUR | 0649 | ى | ـى | | |
| YEH | 064A | ي | ـي | ـيـ | يـ |

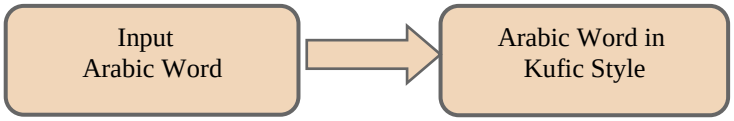



Figure 2. Aim of proposed method

The grid board has a fixed size involving all Arabic alphabets in overlapping form as a method to trace the shape of each letter. In the following subsection, the proposed method is explained in details (See Figure 3).

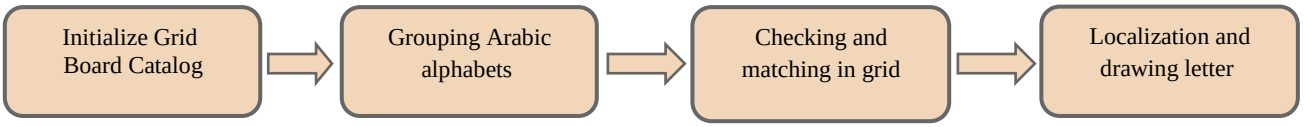



Figure3. Proposed method steps

*4.1. Initialize Grid Board Catalog*

A grid is a large a progression of straight vertical and level lines. A lattice subdivides a structure vertically and evenly into columns and sections. These subdivisions shape the premise of a secluded and efficient way to approach the formatting of characters. A graphic-design grid help the planner choose where to put things [11]. At its most basic, units (or points) determine the sizes of a grid's component parts. In this paper, the size of the grid board is 18×14 cells, with each cell being measured in 25 points.

All Arabic alphabets in Kufic font are described in this grid in a simple and easy method so that similar letters can be grouped together. Each letter is represented by a set of points on x-axis and y-axis, depending on the glyph of letters in Kufic font (See Figure 4).

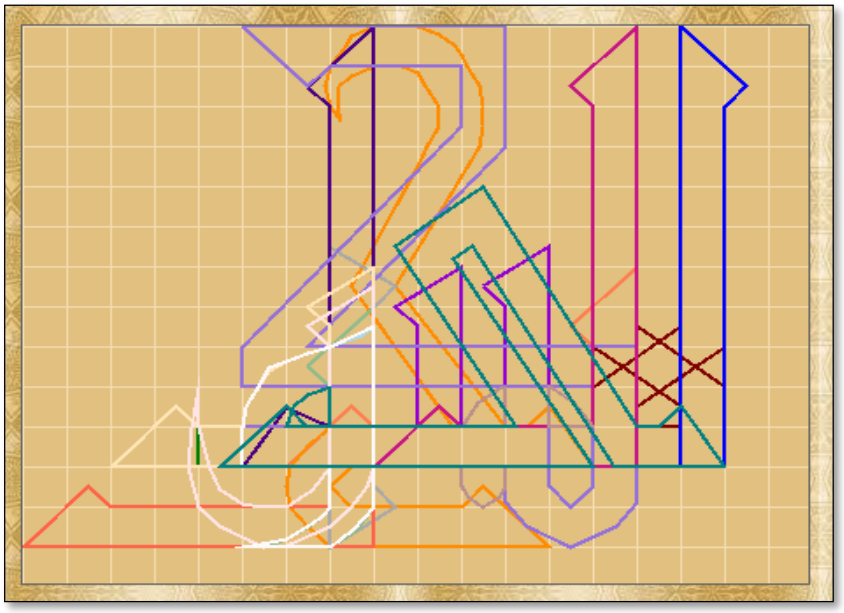


Figure 4. Grid board catalog

*4.2. Grouping Arabic alphabets*

Many characters in Arabic are similar in sub shapes, such as DAL and THAL, RAH and ZAIN, WAW and QAF, etc. For example, the letters WAW, MEM, FEH, and QAF are grouped together to reduce the complexity of each shape by overlapping (See Figure 5).

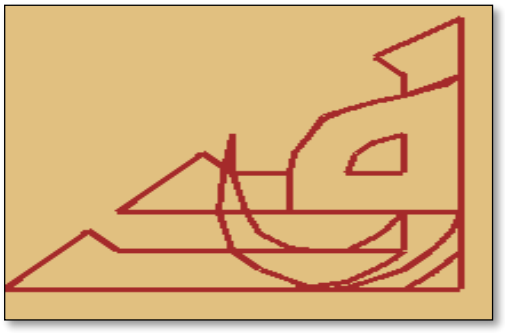
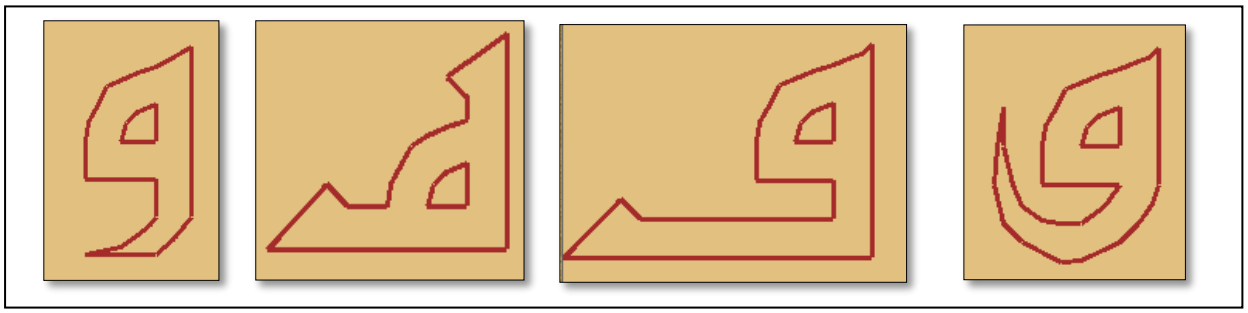


Figure 5. Four Arabic letters grouped together with overlapping



The four letters without overlapping was explained in figure 6; all of these shared in sub shape.

Figure 6. Four Arabic letters without overlapping

There are six groups arranged in this paper. These groups contain the letters similar in sub part of letter's shape (in initial, medial, or final) part. In other words, these letters shared in sub points of their shapes (See Table 3).

Table 3. Grouping Arabic alphabets

| Groups | Unicode | Glyphs |
|---|---|---|
| Group1 | Isolated Form | ا،ل |
| | Not Isolated Form | ـا،ـل،ـلـ |
| Group2 | Isolated Form | ء،و،ؤ،ر،ز،ق،ف،ن،م،ة،ه |
| | Not Isolated Form | ـة، ـه،ـف،ـق، ـم، ـن،ـو،ـؤ،ـر،ـز، ـمـ، ـمـ،ـفـ،ـقـ |
| Group3 | Isolated Form | ب،ت،ث |
| | Not Isolated Form | ـبـ ،ـتـ، ـثـ، ـنـ، ـئـ، ـيـ،ـبـ،ـتـ،ـثـ، ـنـ، ـبـ، ـتـ، ـثـ ،ـيـ، ـنـ |
| Group4 | Isolated Form | د،ذ،ص،ض،ط،ظ،ك |
| | Not Isolated Form | ـصـ،ـضـ،ـطـ،ظ, ـد،ـذ،ـصـ،ـضـ، ـطـ،ـظـ،ـكـ،ـص،ـض،ـط،ـظ،ـك |
| Group5 | Isolated Form | س،ش،ع،غ،ى،ي |
| | Not Isolated Form | ـسـ،ـشـ،ـعـ،ـغـ،ـهـ،ـس،ـش،ـع،ـغ، ـئ،ـي،ـى |
| Group 6 | Isolated Form | ج،ح،خ |
| | Not Isolated Form | ـجـ،ـحـ،ـخـ،ـجـ، ـحـ،ـخـ, ـجـ،ـحـ،ـخ |

*4.3. Checking and matching in grid*

In this stage check the status of letter, the steps of checking illustrated in Figure 7.

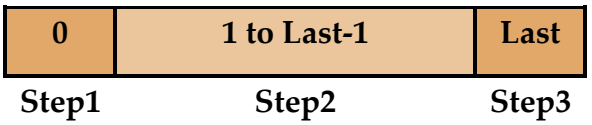



Figure 7. Checking steps

In Step 1, check the letter in index=0 to decide whether it is an isolated or connected letter. The isolated letters are these six: ALEF, DAL, THAL, RAH, ZAIN, and WAW. When the letter in index=0 is connected, that means it is in its initial form.

Then the rest of the word is checked sequentially in Step 2 until reaching the end of word. The main purpose of this step is to check the status of letters in second location until the end of the word. In short, this step requires checking the previous and next letters.

Finally, in Step 3, check the last character in the Arabic word. The flowchart in Figure 8 explains the details of this stage.

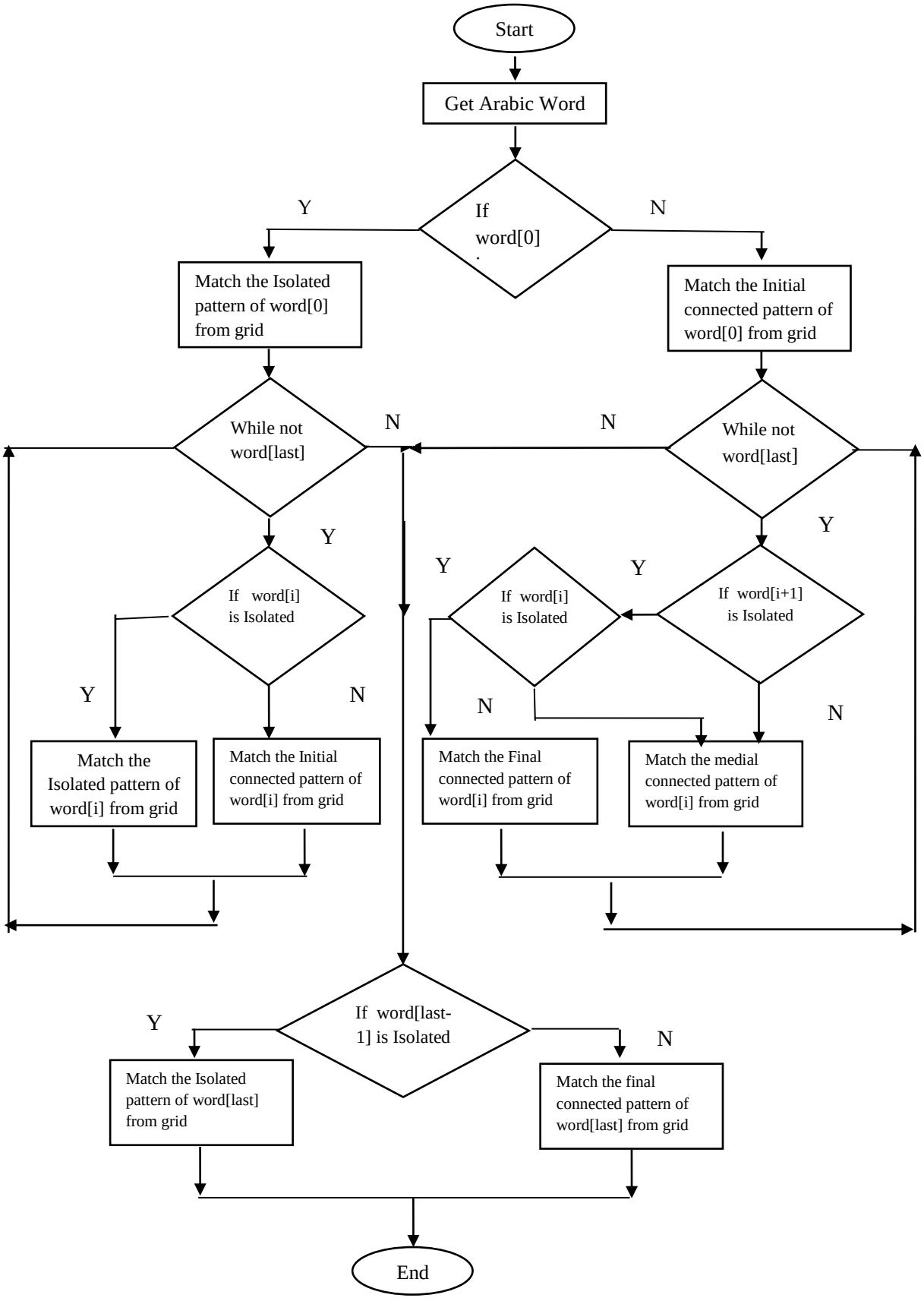



Figure 8. Proposed method steps

*4.4. Localization and drawing letter in Kufic font*

Localization process can be implemented by using the two-dimension transformation matrix to get the desired letter in writing board. This step depends on:

- The position of letter in Arabic words: initial, medial, or final position.
- The position of letter in grid board: the x-axis and y-axis point values.
- The letter dimension itself: width and height, which is implemented by using the procedure to get max (point in x-axis) and max (point in y-axis).

A letter was displayed by sets of coordinate points. The aim of geometric transformations is to calculate new coordinate positions for these points. In this paper, a translation transformation was needed, which is a straight-line movement of a letter from one position to another. We translate a point from coordinate position (x, y) in board catalog to a new position (x', y') in the writing board by adding translation distances, Tx and Ty, to the original coordinates: x' =x+Tx, y' =y+Ty. See Figure 9 [12,13].

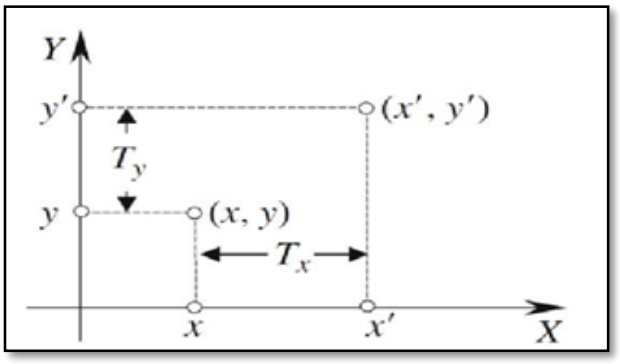



Figure 9. Translation in two-dimension

**5. GUI of proposed method and results**

Graphical user interface (GUI) is a collection of techniques and mechanisms that allow the user to interact with the computer. GUI consists of objects (what people see on the screen) and actions (what can be done). The corresponding GUI for the generated Kufic

font was shown in Figure 10, which reflects the capabilities of teaching, writing, and generating Kufic font in Arabic scripts.


Figure 10. GUI of generating Kufic font

The objects represent graphical elements that are fire and react to events. The proposed software has more advanced features listed in the following:

1. Learning process:
    - Display the glyphs (shapes) of all Arabic letters by object ("show Catalog") , these glyphs are considered based on Arabic calligraphers in Kufic font, as shown in figure 3.
    - Learn the method of writing any letters by choosing it and show the steps of drawing it. For example choosing letter "TAH" , see figure 11.
2. Generating process:
    - Any word can be generating in Kufic font depending on flow chart in figure 8, the desired glyph of any letter explained in catalog board, more examples shown in figure 12.


Figure 11. Learn letter "TAH" in Kufic font

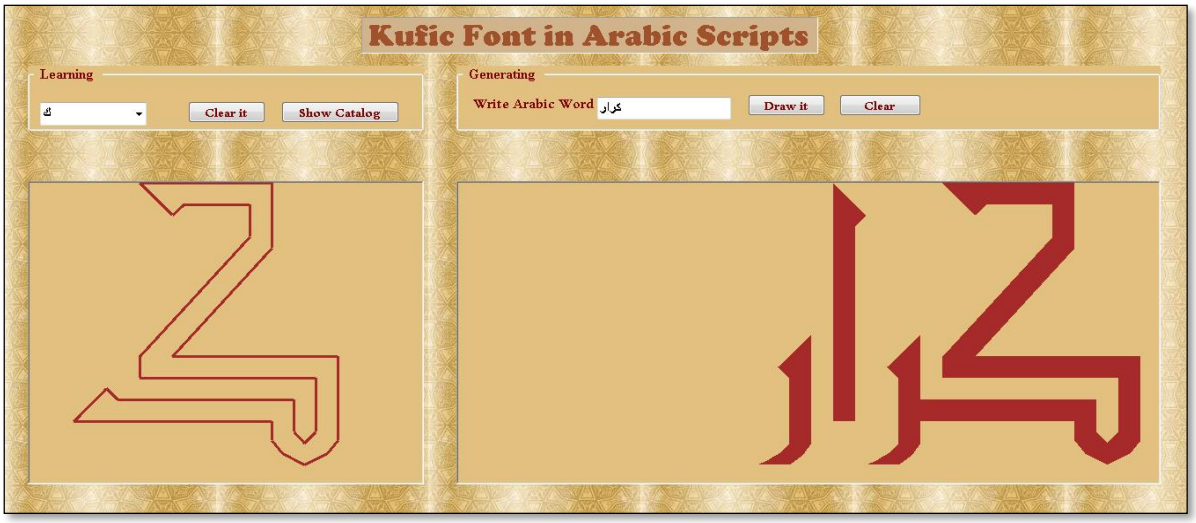



Figure 12. Generating word "كرار" in Kufic font

The glyphs of Arabic letter "SAD" with all possible position (in initial, medal, final and isolate) are explained in figure 13.


Figure 13. Generating word "صصص" in Kufic font

## 6. Conclusions

Islamic calligraphy is an integral part of the Islamic cultural tradition, relying on the aesthetics of calligraphy for spiritual expression. Making calligraphy is a highly respected art form. Therefore, this paper focuses on learning and generating all Arabic alphabets in Kufic style. As we have shown from this paper, the Kufic calligraphy style has regular geometric components (lines, circles, curves, arcs, etc.) which can be learned and generated easily by a grid board catalog. The proposed method explains all Arabic alphabets in the unique grid which share some parts of letters shaped by overlapping. The principles of coherence and aesthetics are involved in the friendly GUI of proposed software, as well as the facilitating learning for all ages of people. This software surpasses the difficulties in classical methods of Kufic calligraphy style learning by providing an electronic method that provides all shapes of letters with generating any Arabic word as an example of learning.

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