

**AC 2007-2973: NEW DEVELOPMENT OF A KARNAUGH AND
QUINE-MCCLUSKEY INTERNET BASED DIGITAL DESIGN PROGRAM**

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New Development of a Karnaugh and Quine-McCluskey Internet based Digital Design Program

Abstract

This paper summarizes the development of the JKarnaugh V4.2 program that allows the Internet user in an open style to manage and implement solutions for digital electronics functions that will be implemented using the Karnaugh and Quine-McCluskey method as well as the Petrick one.

Introduction

This paper presents the JKarnaugh V4.2 program that allows the Internet user applying the Karnaugh and Quine-McCluskey algorithms for any digital function to get the minimized one. The program is based on an open application developed in java and is available over Internet¹ (Figure 1 and 2 show the presentation screens and Figure 3 show the main screen of the program). Although the program is developed in Spanish all technical users could gain by the advantages of the program since it uses a graphical interface prepared for every user.



Fig. 1. JKarnaugh V4.2 main presentation (info) screen.

In the Figure 1 it includes information about the author and the program and in the Figure 2 it includes five general links:

1. Information on Karnaugh technique (*Qué es Karnaugh*) as well as the foundation of Boole Logic.
2. Information on Java programming (*Qué es Java*).
3. Some different Java applets examples (*Ejemplos de Applets*).
4. JKarnaugh V4.2 program entrance (Simplificar Función).
5. And the programmer author e-mail link (@Author).



Fig. 2. JKarnaugh V4.2 presentation (general links) screen.

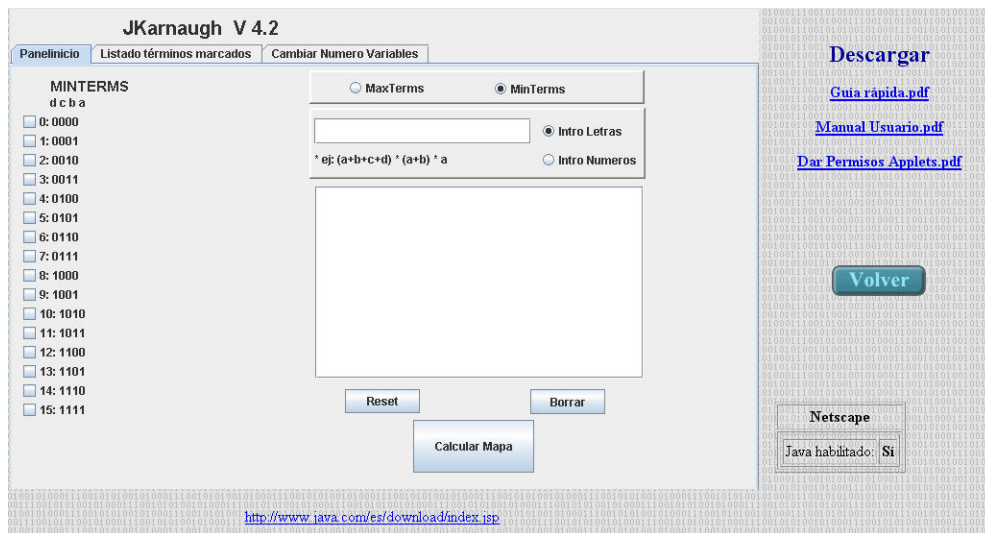


Fig. 3. JKarnaugh V4.2 application main screen.

Background

This new program is developed after the review of Internet Open Source Programs available to help the learning of Karnaugh and Quine-McCluskey digital design then we notice there was an open opportunity to provide a new program that would cover this purpose and could give support to students, who would like to learn these techniques. The main review included the KV-Diagram-Applet², Karnaugh Minimizer Pro³ and Karnaugh Map 1.2⁴, all of them obtained by Internet. In these programs, there were developed a battery of digital functions test to review all the working features of each program and there was finally done a text which needs to be solved by the Petrick method where all the three previously selected applications failed to minimize.

The first program analyzed, KV- Diagram-Applet (Fig. 4), was very difficult to use and the user learning time is really high. It was really hard to use and was rejected in the first review time.

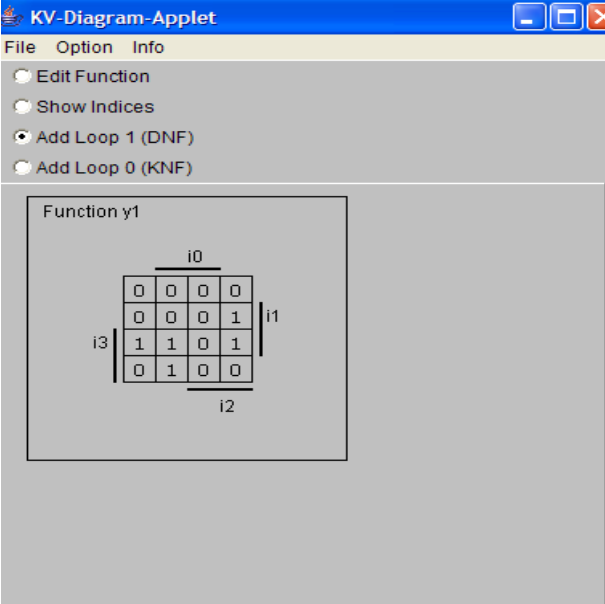


Fig. 4. KV-Diagram-Applet program.

Karnaugh Minimizer Pro (Fig. 5) was a shareware program intuitive and easy to use that includes a graphic and text output view but does not have the Karnaugh map in the classical expected view.

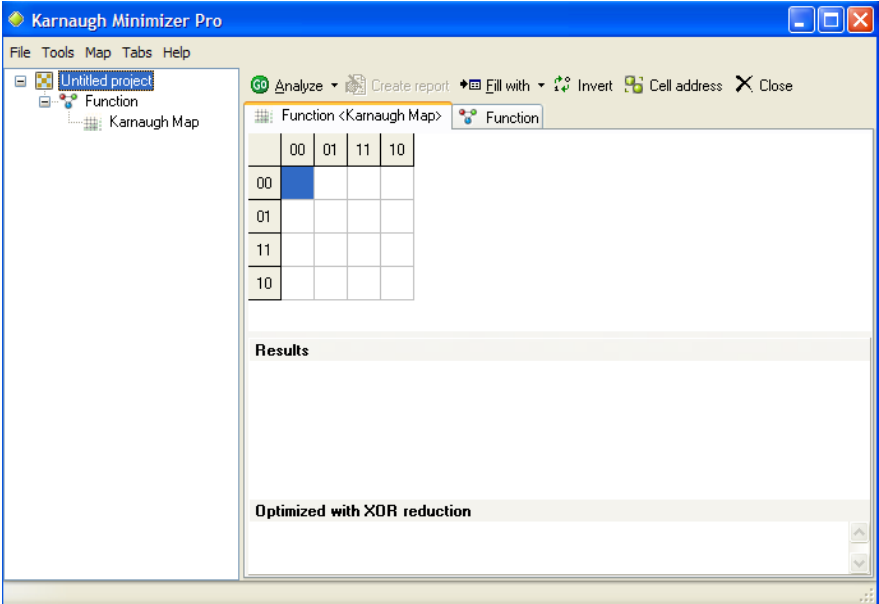


Fig. 5. Minimizer Pro Program.

Karnaugh Map 1.2 was the final program analyzed (Fig. 6) and it was simple and easy to use this application. It shows the Karnaugh map and the text but there is an unknown relation between the digital term and the graphical output.

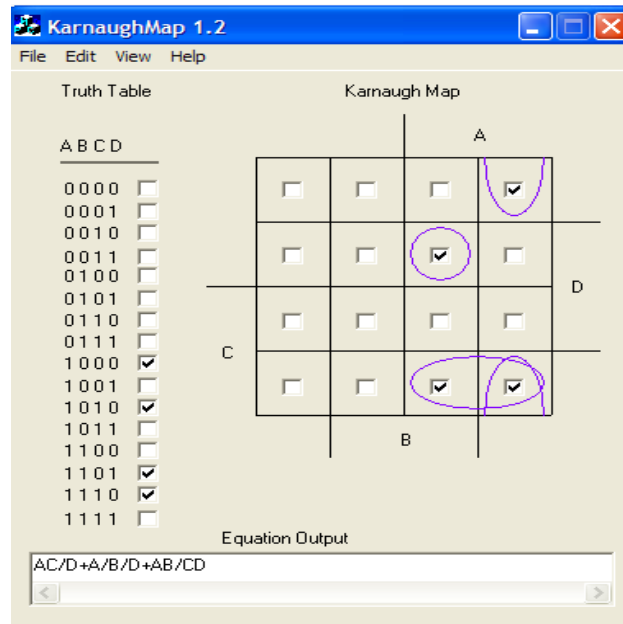


Fig. 6. Karnaugh Map 1.2 Program.

Development

We focus our development on the user (mainly student) as cornerstone then we will consider users as engineering students that would like to learn by Internet.

Karnaugh minimization method is mainly a manual which is oriented to students as an easy way to minimize functions when they have a small number of variables. Quine-McCluskey is a programming method so that we would like to include this method supporting Petrick method too in our development.

We develop the battery test that was used with the other programs. This will provide us the final test, which will solve and minimize digital function that won't include essential implications or equivalents or dominants elements. The only way to solve this is using the Petrick method. All the used programs didn't solve this problem on the contrary of our system.

The developed system, JKarnaugh V4.2 has the following features:

- Easy use of the Internet interface in everywhere accessible.
- Open source and Java developed: independent of the operating system.
- Easy to define the digital problem to solve: number of variables, input values, working method, etc.
- All information can be accessed by a user clicking on the respective button of the screen.
- Features until 10 input variables (much higher than the normal user can understand).

- Input and output information clear and well separated.
- Minterm and Maxterm support.
- Graphic map generation.
- User can save a new design support.

A new graphical weight based on our algorithm allows easy and fast procedure to draw the output of the system in a traditional view (Figs. 7, 8 and 9).

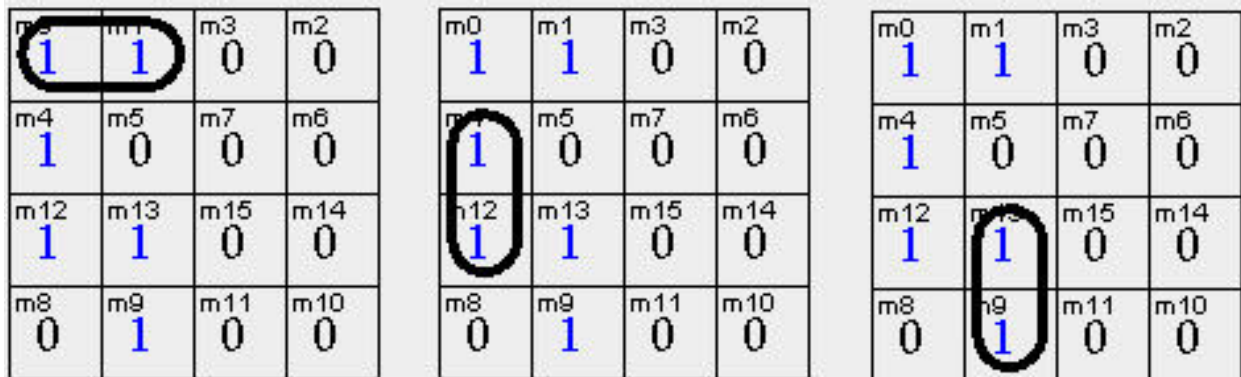


Fig. 7. Karnaugh Map Graphical view.

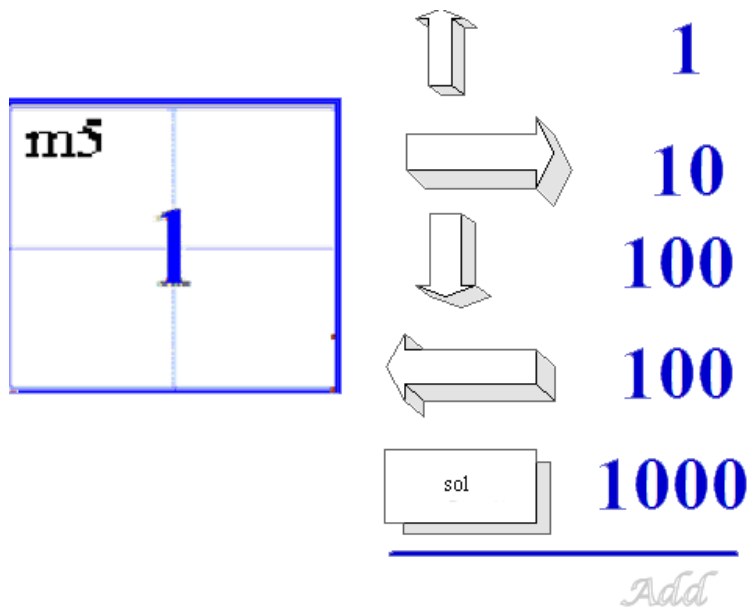


Fig. 8. Karnaugh Map near-places calculation view.

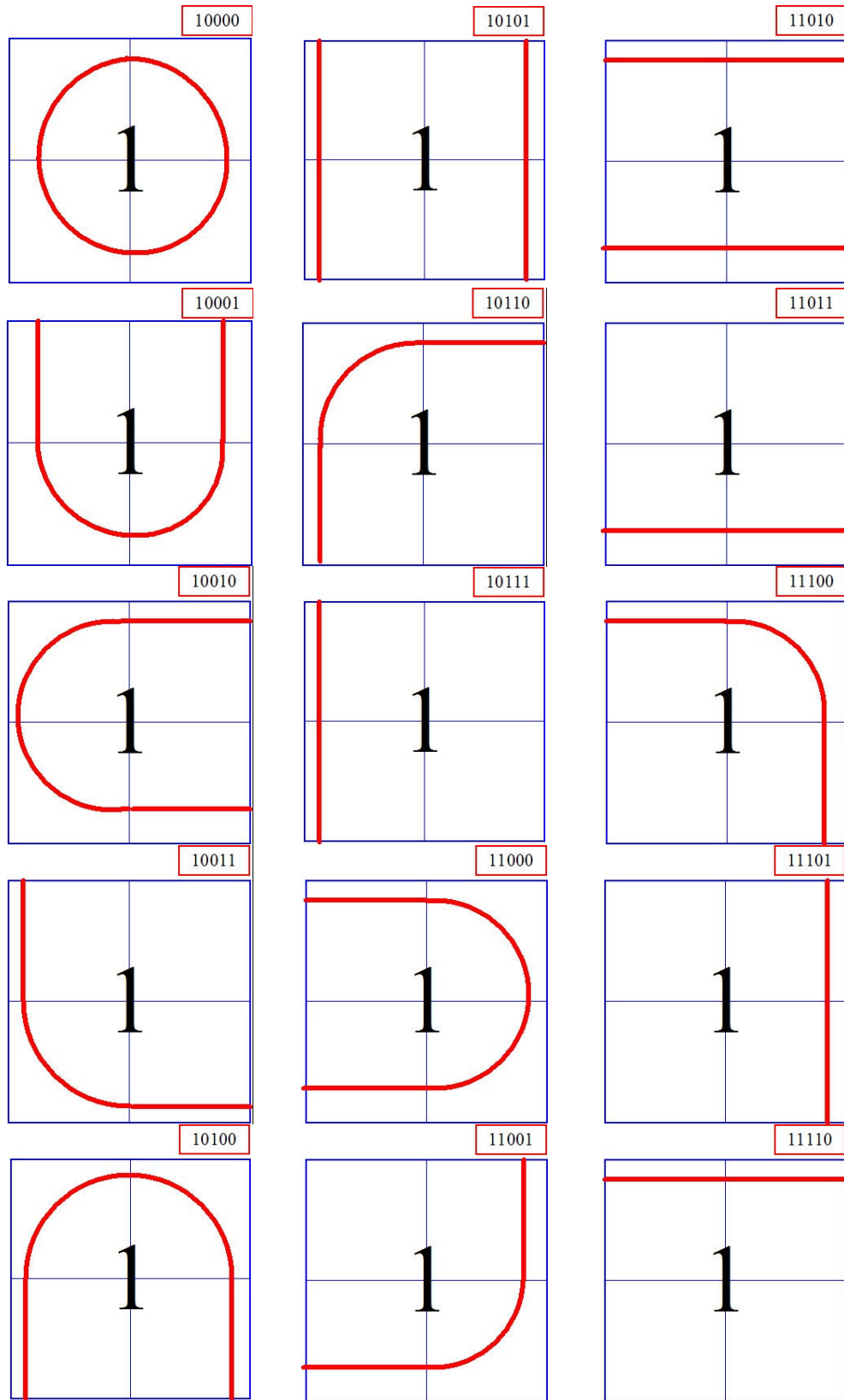


Fig. 9. Karnaugh Map near-places view.

Operation

The Java program developed is accessible by Internet in Spanish language and the URL is included in the references¹.

Figure 3 shows the area joint for the Karnaugh and Quine-McCluskey application (main part) with some links and a main button (*Volver*) to return to the previous screen (Fig. 2):

1. Three main flaps to address the Main Panel (*Panelinicio*), to list the selected digital terms (*Listado términos marcados*) and to configure the number of digital variables (*Cambiar Numero Variables*).
2. Inside the Main Panel, the user can choose between:
 - a. Working with maxterm or minterm,
 - b. Introducing between three different logical function (mark the placeholders for each digital term, write the logic function with digital letters or write the logical function with numbers),
 - c. After the introduction of a digital function the user can see the function in the second flap (*Listado términos marcados*).

One example could be to minimize the digital function $f(d, c, b, a) = \sum (0,1,4,9,12,13)$ which solution is

$$d'c'b'* + *cb'a' + d*b'a$$

or

$$000* + *100 + 1*01$$

The user could mark the placeholders directly in the main area or include the letters function or the numbers function (0+1+4+9+12+13 [ENTER]) (Fig. 10).

The screenshot shows the 'JKarnaugh V 4.2' application window. It has three tabs: 'Panelinicio', 'Listado términos marcados', and 'Cambiar Numero Variables'. The 'Listado términos marcados' tab is active. On the left, under 'MINTERMS', there is a list of 16 terms (0: 0000 to 15: 1111) with checkboxes. Terms 0, 1, 4, 9, 12, and 13 are checked. On the right, there are radio buttons for 'MaxTerms' and 'MinTerms', with 'MinTerms' selected. Below this is a text input field containing '0+1+4+9+12+13' and a 'Reset' button. Another text input field contains '*ej: 0 + 1 + 24 + 344' and a 'Borrar' button. At the bottom, there is a 'Calcular Mapa' button. There are also radio buttons for 'Intro Letras' and 'Intro Numeros', with 'Intro Numeros' selected.

Fig. 10. JKarnaugh V4.2 data introduction.

Once the data is correctly introduced, the user can choose to solve (*Calcular Mapa*) the digital function and get the graphical map view (*Mapa de Karnaugh*) (Fig. 11) or the text view (*Solucion*) (Fig. 12).

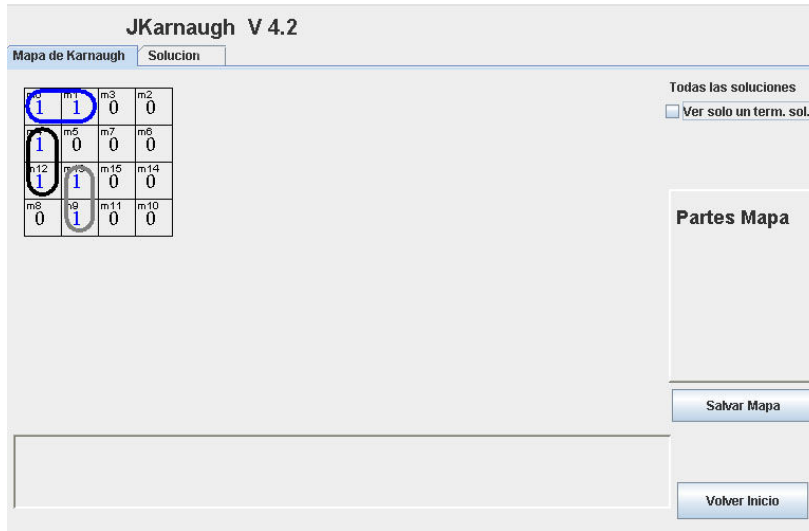


Fig. 11. JKarnaugh V4.2 map graphical view.

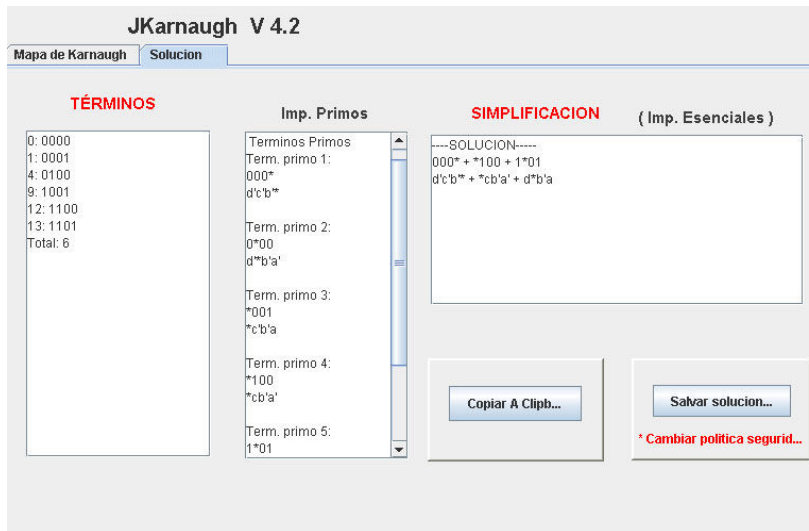


Fig. 12. JKarnaugh V4.2 map text view.

Conclusions

One general impression in our global world is that all is already done and all is developed or invented. But there is a wide way to improve different applications if we have an open view of them and if we develop high educational tools for users. In this way we have developed a new application based on Java to implement the Karnaugh and Quine-McCluskey digital functions to solve digital problems and designs.

Acknowledgements

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