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The Selection Method of Skelton of the Objects Based On a Cellular Automation for an Efficient Description of theImage

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Abstract:*The paper presents a method for the effective selection of the skeleton of local objects in complex images with the use of cellular automata. The method allows to sequentially selecting local objects as well as their skeletons in the visual scene. Selecting the skeletons of the object carried out by means of a special organization of Cellular Automaton(CA) on which the image is recorded. Image description based on its skeleton is carried out by the algorithm describing the skeletonization, which makes it possible to restore the original image without loss. Schemes and VHDL-model cells of the main and additional layers of cellular automata are designed.*

Keywords:*image, cellular automata, skeleton selection of objects.*

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I. Introduction

Today, an important task in the field of data processing and transmission is a task of efficient image compression whichreduces memory capacity and increases the speed of data transmission by communication channels.Several papers have considering this topic and describedthe different methods of hardware and software implementation [1-4].

Complex image description and image compression divide the image into a set of separate objects. The location of each local object and its interrelations with other objectsare defined. In this context, cellular automata (CA)is effectively used[5].However, the selected objects have local redundancy. For an optimal description of the local object the methods of skeleton image selection are used [6]. Most of the methods used for selecting skeleton imagesare based on the use of sophisticated data analysis. The possibility of parallel execution on computing architecturesis not taken into account.PartofthealgorithmsarebasedontheconceptsofVoronoidiagramsandDelaunaytriangulation, [7].

This article focuses on the use of CA for effectively selecting skeletons of local objects in complex images.

II. The Image Description Method Based On The Skeletons Of Local Objects Of A Complex Image

The code that describes the image should contain information about the method of a characteristics selection and their sequence.The following processing steps can be used to effectively describing complex binary images:

1. The images in CA are recorded.
2. Objects in complex images are selected.
3. For a description of each of the selected objects, the skeleton selection (image thinning or skeletonization)is carried out.
4. Each object skeleton is described.
5. The location of each selected skeleton is described.
6. A common code for a complex image is described.

Selecting skeleton is also called thinning or skeletonization image.

The skeleton of the image consists of fewer digital elements and carries information related to the topology and shape of the image.

Selection skeleton image task is used to describe the image in a compressed form. At the same time, the image description in the form of a skeleton should include the key values of the elements of the skeleton selection algorithm. This is necessary to restore the original image by describe its skeleton.

If one uses a simple approach that is basedon elementary rows and columns scanning, the description of the image on the skeleton will not have a complete compression code.Other scale-changes methods can be used, but they do not provide the minimum skeleton, and require complex intermediate calculations.

To effectively describe the image on its skeleton, CA gives good results. The shape of skeleton image of the object depends on the selected neighborhood and CA coverage.

III. Skeleton Image Selection Proposed Algorithm

The task of selection skeleton image involves the representation of its structure which has a smaller number of cells. At the same time, information about the shape of the object needs to be preserved. In view of the previous steps on the allocation and fixation of objects in the additional layer [8-12], each object can be processed separately.

After selecting an object in the additional layer, its fixation is carried out to determine the skeleton selection algorithm. For this purpose, CA is used.

The skeleton extraction algorithm is as follows:

1. The selected object in the CA field is determined.
2. The number of columns n and number of rows m is calculated.
3. The number of cavities in rows and columns is determined.
4. If there is no cavities then of two numbers n and m less are selected.
5. The edge cells in rows (or columns), if m<n (or $m > n$) at each time cycle are rested into the zeroes.
6. In each row (column),one or two cells contain information about the number of reset cycles.
7. The remaining cell is stored in the base layer.
8. The remaining cells are reset; and the information is stored in the cell of the intermediate layer. This cell is stored in the gap between the two remaining basic layer unit cells.

A fragment of the generalized structure of the CA with the basic and additional layers of cellsis shown in Fig. 1.

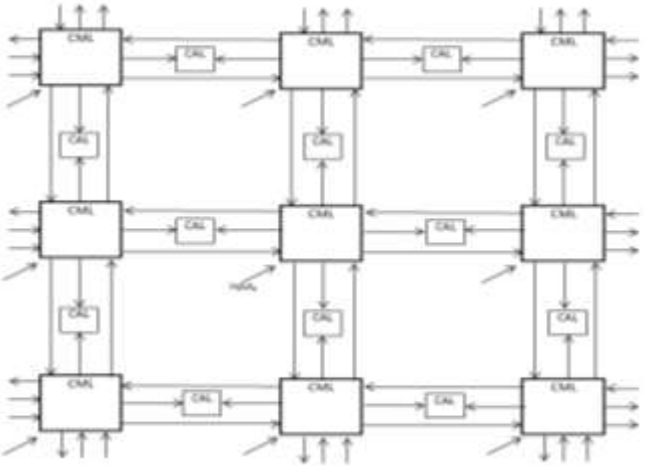


Fig. 1A fragment of the CA with the basic and additional layers.

CA contains basic layer cells (CML) and an additional layer cells (CAL).

All CMLs are connected with the neighboring CMLs by columns and rows, as well as with neighboring CALs, which are located between neighboring CMLs [13-15].

Neighboring CMLs shall exchange signals; and each CML transmits information to neighboring CAL.In the algorithm, the system counts the number of rows $m$and columns n. This is carried out in order to reduce the number of cells forming the skeleton. Skeleton images selection can be exemplified by the rows and columns shown in Fig. 2.

In Fig. 2, the circles show an additional layer cell. The numerical values indicate the number of clock cycles to restore the full image from the CML cells. The square cells show the values of the number of cycles for CML.

Fig. 2. Example of skeleton image selection.

This example shows that if there are cavities, the algorithm will not be always effective. Therefore, an additional operation is performed if the cavities are defined. Cavitiesare also defined in columns and rows. A cavity or gap in the row image marks the existence of a background cell in the row, which is located between the cells of the image. If we have k cavities then as a result will have k+1 cell. It will be described image after the skeleton selection.

In this case, counting the number of cavities is performed in each row; and the number of cells describing the skeleton in rows and columns is calculated. The least amount and skeleton are chosen.Each CML should count the number of clock cycles that areexpended on skeleton selection. Moreover, if the CML is an edge cell of the image, it is reset to zero. With each clock cycle all image cells increase their own value by one; and edge CML is reset to zero.

IV. Skeleton Image Selection Implantation

The functional diagram of a CML is shown inFig. 3.

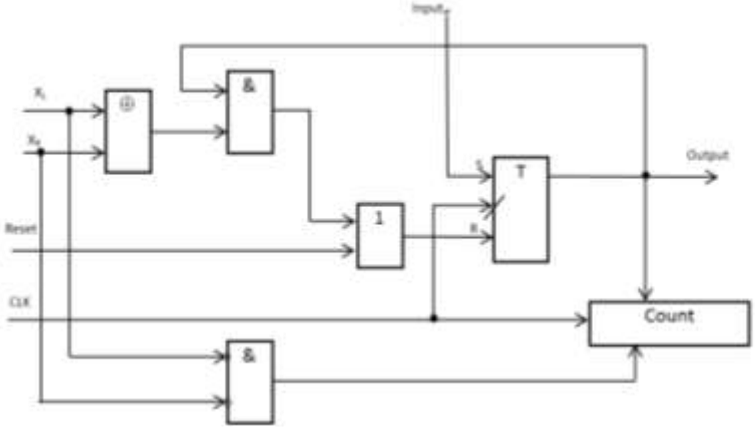


Fig. 3. Functional diagram of one CML to perform the operation in the row.

CML circuit comprises a synchronous RS-trigger and OR, AND, XOR elements. Trigger control circuit as well as its output function are implemented as follows
$f_{output}\ (t+1) = f_{output}\ (t) \wedge [X_L(t) \oplus X_R(t)]$,
where$f_{output}\ (t)$ – signal at the trigger output at time point;
$X_L(t), X_R(t)$ – signals at the outputs of the neighboring left CML and right CML at time point.
CML is operated to reset those cells with logic "1" state. Neighboring cells have logic "0" and logic "1" states.The counter counts the number of clock pulses during the presence of the logical signal "1" at the trigger output. If the trigger goes into a logical "0", the counter displays a value of 0. If the trigger outputs, and a second AND element have logical "1" presented, the counter no longer counts.

The functional CAL diagram is shown in Fig. 4.

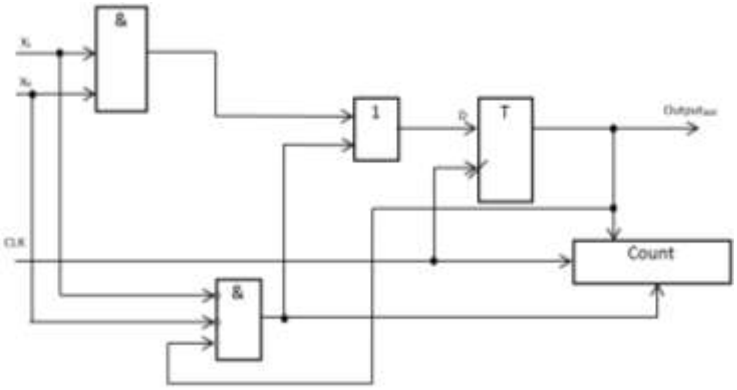
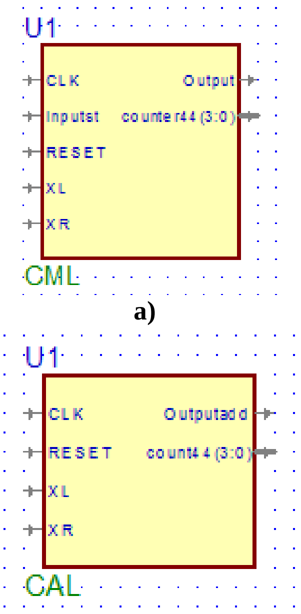


Fig. 4. Functional CAL diagram.

CAL also includes D-flip-flop, a counter and logic elements which control the state of flip-flop. The counter counts the number of CLK pulses when the two neighboring CMLs do not pass into a state of logical "0". In this case, the output D-flip-flop has a signal of logical "1".

If at least one of the two neighboring CMLs is set in a logic "0", and the other neighboring CML is set in a logic "1", the flip-flop and the counter go to zero state.

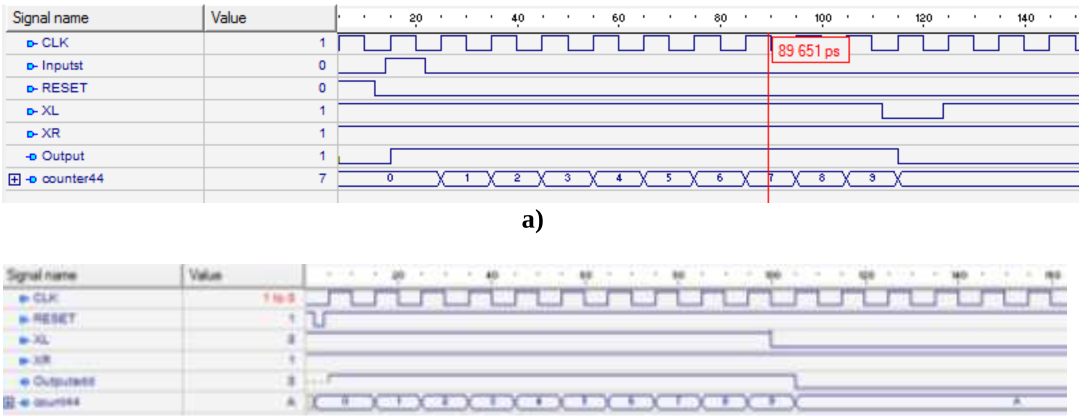
Both cells are modeled in CADActive-HDL (Fig. 5, a,b);and their timing diagrams are shown inFig. 6,a,b.



a)

b)

Fig. 5. Model ofCML,a) CALb) implementation of FPGAs.



a)

b)

Fig. 6. The temporary work diagram ofCML,a) CAL,b)implementation of FPGAs.

Standard cellular automata are described by classical definitions. CA standard cell changes its state based on the states of neighboring cells, and thus, the field changes its state. CA themselves have an internal structure that depends on the task in the processing array. But for speed, they are divided into two large classes: structure to perform operations per clock cycle; structure to perform operations at time that depends on the array that is processed and on the character the operations. Using CA allows us to efficiently select the skeleton of local objects in complex images with the use of cellular automata.The obtained models showed high reliability of operation and ease of implementation.

V. Conclusion

Thepaperpresents a methodfortheselectionofthelocalobjectskeletonfortheefficientdescriptionofcompleximagesWithcompression.The method allows calculating the minimum number of cells which describe the image of the object. The obtained results reduce the amount of data expended on the description of complex images.

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