Segmentation of Images based cellular Automata-Reactive Agent Implemented in Netlogo Platform

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ABSTRACT
In this paper, a method based on a coupling multi-agent system and cellular automata to solve a problem of image segmentation, is developed. The used agent is of reactive type. The creation and the death of agents are related to the development of cellular automata. In this work a cellular automata is as a grid of cells of planar structure (image segmentation), with a Moore neighborhood is proposed. Two functions of transitions are used to vary cellular automata; and each agent will get two states. In order to validate this work, NetLogo platform is used and applied to mammograms, and results are satisfactory.

Keywords
Image segmentation; multi agent system; cellular automata; mammograms.

1. INTRODUCTION
The Cellular automata are a particular model of dynamic systems discrete. These are regular system of cells, all identical, with each and every moment a state from a finite set, and developed by synchronous and uniform application of a rule for updating locally defined. They are used for modeling of natural phenomena diversity (laws of the universe),but before they are constitute a model in itself, remarkable by a formal simplicity and able to produce behavior of great richness and often difficult to predict[1].The Agent-based computation has been studied for some years in the field of artificial intelligence and has been widely used in other branches of computer science. Multi-agent systems are computational systems in which several agents interact or work together in order to achieve goals. Agents in such systems may be homogeneous or heterogeneous, and may have common goals or distinct goals [2].Previous work on multi-agent systems has generally focused on areas such as simulations of social and biological systems, problem solving, communication, collective robotics, and electronic commerce on the Internet.
Artificial life has been successfully used for understanding biological systems and in many applications in robotics, computer graphics, etc. In this paper, we pioneer the use of artificial life for image segmentation, The approach "artificial life" provides for image segmentation a chance to learn new techniques more efficient, more flexible or just a little unusual, Section 2 presents a brief description of multi-agent system the Section 3 is devoted to cellular automata and their characteristics The proposed approach is described in Section 4, its implementation through Netlogo is given in Section 5. The article ends with the presentation and discussion of results.

2. TOPOLOGY OF AGENT
Agents can be classified into two categories principal categories according to their behavior and granularity .these notion of granularity is of course very subjective, it expresses the complexity of "reasoning" of an agent to in order to separate intelligent agents from less "intelligent" agent. We talk of cognitive agents and reactive agents. These are two schools of thought and a real cleavage. The first of cognitive agents, consider an aggregate of such agents can be practically treated as distributed expert systems. Knowledge of expert systems in question are used for the representation of the world that the agent is modeled and for express his intentions to actions .The second school, the reactive agents, does not follow the cognitive paradigm and considered an agent of this type, does not have a global view of the system but responds with actions to stimuli. This is typically the case of an "ant" in its environment "anthill. The Communication between reactive agents is performed using reagents propagation of signals having an intrinsic meaning but devoid of semantic deep, in our article we will interest precisely to reactive agents type [3].

3. CELLULAR AUTOMATA
In section the concept of cellular automata is introduced, in this concept a collection of individuals, called cells, and its behavior is governed by a local rule called: rule of transition or (function of transition). This rule is called local as it does not take into account the state of all cells .however only the state of neighboring cells of all cells that we will update. In case of all cells are updated at the same time, we talk of synchronous updates otherwise the update asynchronously [4].
In mathematical terms can be defined as:

$$S_i\,(t+1) = F\left(\{S_j\,(t)\}\right)\, j \in V_i \qquad (\mathbf{1})$$

-A system of cells {i} in a space of D dimensions.
-A set of states for each cell. It usually has the same number of possible states for all cells of the system, k is an integer greater than or equal to 2 .With rule F determines the state of a cell at time t +1 based on the state of the concerning cell and its environment at time t.
-where $V_i$is a set that includes the cell itself and its surroundings [1].

3.1 Properties of cellular automata

The first important property, in cellular automata (CA), is the symmetry where all cells are identical in the sense of subject to the same rule and the same topology. A remarkable phenomenon is that despite the simplicity of the rules of the CA and its constitution, they can represent very complex phenomena.

The second one is the description of (time and space),Some problems like social phenomena are very difficult to model. In addition is the unique concept that can be model this phenomenon, as it often nonlinear. This principle where cellular automata coupled with the multi-agent system produces global behavior can emerge from the particular structure [4].

4. NETLOGO ENVIRONMENT

The proposition mentioned after this section is implemented in Netlogo platform this platform have advantage to be planned in JAVA ,wish give portable on any machine(windows..).It is simple to manipulate and have the tools integrated to enable a easy treatment result as a graphical illustration. Principal advantage for this language is to enable modeling of complex system for the infinity number of autonomous entity situate in static or dynamic environment, and work parallel. Netlogo enable the modeling of autonomous entity comportment in micro level and emergent comportment in macro level. Netlogo world is constituted of agents [5].

5. THE PROPOSED APPROACH

We have inspired from the many works and courante of thought in less or more way explicit, Multi-agent system [6], the Game of life automata [1] is not absent in our inspiration, from what we are push the biological paradigm and define the birth and death of cellular. To begin with a fixed number of autonomous entities are deployed randomly in the image. This entities is equipped with an ability to estimate the homogeneity (Computing local variable) of a region in a predetermined location [7].

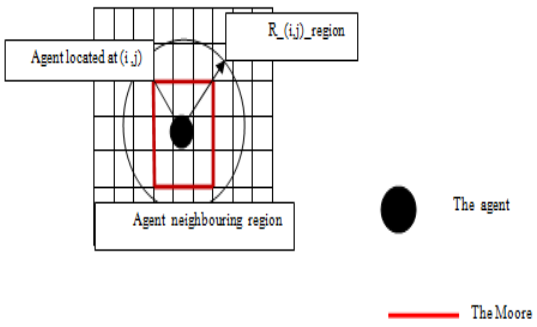

Fig 1: The local neighboring region of an agent at location (i, j)

Before declaring the behavior of our agent, we define environment what a digital image (2D) where:

$$\boldsymbol{A} = (\boldsymbol{I_x I_y})$$

Where: I_x et I_y are intensity of relative pixel at (x, y).

To assume a homogeneous segment in an image mathematically we have chosen the density distribution.

$$D_{(i,j)_{region}} = \sum P(i,J,K,l)$$

$$||(i,j) - (K,L)|| \leqslant R(i,j)\_\text{region}$$

Where:

$$p(i,j,k,l) = \begin{cases} 1 & Si\|I(i,j) - I(k,l)\| \leq \delta \\ 0 & otherwise \end{cases} \quad (\mathbf{2})$$

With:

(i, j): pixel coordinates on what is the agent.

(K, L): Coordinates of the pixel neighbor of the agent.

I (i, j): The value of gray level intensity of pixel (i, j)

δ: threshold contrast. It means the difference of intensity admission between the pixel (i, j) and neighboring pixels.

R (i, j) _region: The radius of the area adjacent to a set (using the Moore neighborhood, the radius it fixed at 1).

Secondly the Agents randomly deployed on the image moves in this direction deferential in order to detect a homogeneous segment, in this case the agent perceive its environment and reacts according to a local stimulus cited in (2).

As regards the diffusion it started when the pixel does not repents of criterion of homogeneity, the diffusion consist agent to move to a new location located in a neighboring region of the current location, using a random direction.

On the one hand our proposal is to provide opportunities for entities to randomly select a direction of diffusion, which allows more chance for the detection of homogeneous regions for labeling, and this mechanism allows agents to better exploit this image.

On the other hand this diffusion starts the principle of "cellular automata", this principle allowed to the agents explored the image more quickly because its development not only in estimating the pixel but also the agent or neighborhood. In the same way this automata also allowed the creating a new number of agents to exploit all the pixels and the extinction of agents in order to strip the number of agents on the image. Apply the principle of cellular automata rule inspired the famous cellular automata "Game of Life" for a problem of image segmentation, it is necessary to define the

cellular automata by :the area, neighborhood, all states, transition rules and terms of edges.

- Area: as we can see in Figure 1, the cellular automaton is a two dimension.

-Neighborhood: as we choose to move the image in any direction while the neighborhood is most appropriate is that of Moore (8 neighbors).

-States: There are two possible states for each agent:

(Living-agent, Death-agent)

-Transition rules: if a cell contains an agent that a white surrounded by two or three white agents when the agent is a gray and then dies. If the cell is empty and surrounded by three agents who have a white color when creating a new agent.

-Note that: To an agent who will become a white-gray in the second time, an agent to a gray color will die.

-Boundary conditions :the neighbors concerned for moving agents are the pixels of the image so we can't move outside of the image .we noted that this fact intervened the notion of asynchrony, that where not update, in each round (called iteration), all individuals (all agents of this AC).These agents have a specific parameterize (2) Such as:

$$D(i,j)_{region} \in n_1, n_2$$

With: n_1 ,n_2 predefined constants related to the characteristics of the image to be segmented .Finally to illustrate my approach figure. 2 summarize the preceding descriptions of behavior reactions.

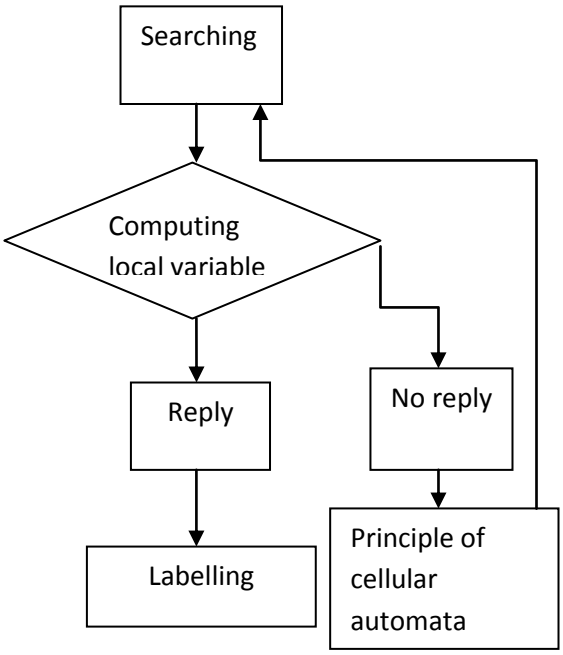

Fig 2: The preceding descriptions of behavior reactions

6. EXPERIMENTAL RESULT

6.1 An illustrative example

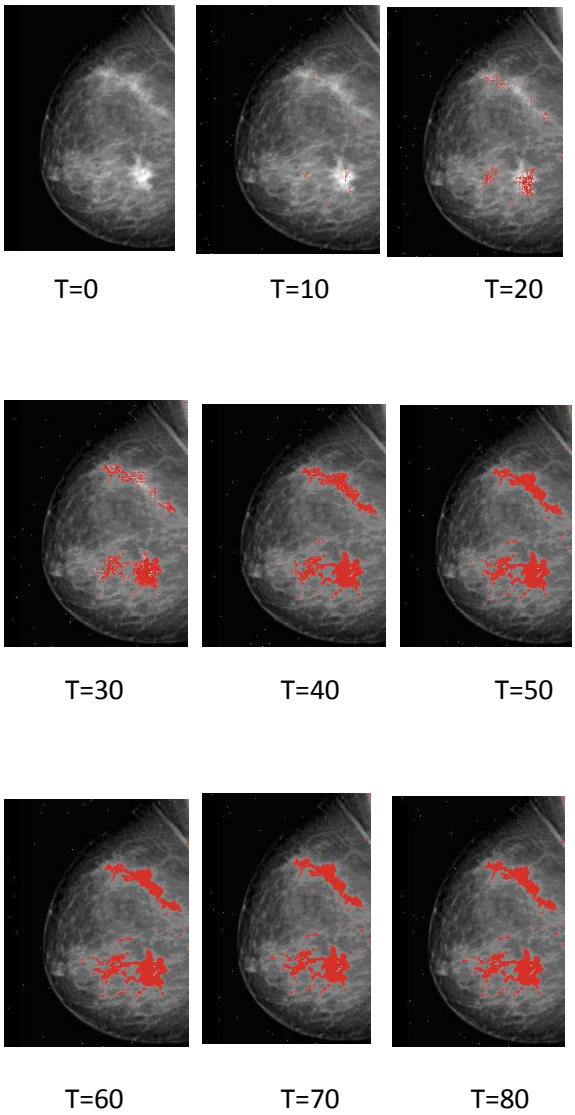

Fig 3: Snapshots of agents-based at different time steps in searching and labeling various homogeneous regions

As a validation of the approach proposed in this section we present an illustrative example. This example is the use of agents for the detection of homogeneous segments (tumor), specifically, we defined a complex picture of the size of (512 x 512), as shown in Figure 3. Searching behavior and the labeling agent is started by its stimuli local and the interaction of cellular automata that repent at certain criteria of homogeneity.

As mentioned earlier, we have not here the question of how best to represent only one segment homogenous but we are interest also if the project based Behavior reactive gents coupled with a cellular automata inspired game of life can show the speed to reach such a segment and a segment this coupling plays the role of an automated agent behavior that is created or to death. Of During the segmentation images we

distributed number 90 agents, randomly distributed on the image. as can be observed in Figure 3 .After a number of stages of evolution we ran our model several times, and we observe the image taken at the end iteration (t=80) it to clear the area homogeneous, and we note that the number of agents and distribution in the initialization plays an important role in the development of automata specifying expected in the transition rules used by the CA.

7. CONCLUSION

We tried in this paper to present a new approach we are used the reactive gents as a segmentation tool of homogeneous areas coupled with the cellular automata .This lost shouts a particular behavior of agents is the creation or death in order to converge to a segmentation of the segment region weak.

We implement this approach on the platform Netlogo, it is a development environment of reactive multi-agent system for the study of complex systems where we can manage hundreds (or thousands) of agents operating simultaneously in an environment .We have applied this approach for several types of images and the results are satisfactory.

In future work we want to use the regional average as a way to fix the number of agents needed in order to segment a region that is to ameliorated the rules of the cellular automata and why not use stochastic automata, the system remains open for ameliorate and introduce strategies for deploying agents to segment images more particular.

8. REFERENCES

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