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Fungus Infestation and Survival a Cellular Automata Based Approach to Solving Digital Maze Images

Preeti Chaudhary, Girish Garg

CSE AITM College

Abstract- Our research is based on the fungus infestation and survival which is a cellular automata based approach to solving traditional digital maze image. Cellular automata technique is used to describe how the elements of a system combined with each other. Each of the elements of the system is denoted as a cell.

Index Terms- Cellular automata, digital image, Digital image processing, John h. Conway

I. Introduction

A maze is a network of paths and walls which is represented as a puzzle where one has to find a path from start to destination point. It considers dead-ends point, entry and exists point to get out in and around the maze. This research works on the part of maze solving which is the way of finding a route from source to destination around the maze. Thereare some maze solving methods which is designed for a player inside the maze having no knowledge of the maze whereas others are designed for a player or computer program can see the whole maze once only.

Some well-defined maze solving algorithms are:

Filled dead end algorithm: it is basically designed to solve a maze that fills all dead ends, leaving the correct path blank.

Wall touch algorithm: it uses the concept of left hand or right hand rule. if the maze is connected in a simple way then keeping one hand on the wall and traverse around the whole maze at-least once and at last will reach to destination point.

II. Research Elaborations:

John h. Conway gave the idea of game of life. He uses three rules to determine next state of cells.

Similarly, Our approach is based on the following steps:

A. Digital image processing:

- A (two-dimensional) digital image is represented as a numeric (normally binary) matrix. The term "digital image" refers to raster images also called bitmap images. The pixels values are stored in computer memory as a raster image or raster map, a two-dimensional array of small integers. These values are often transferred or stored in a compressed form.
- Standard image formats including BMP, GIF, JPEG, and PNG.

Extracting matrix maze from digital maze image

- This Process involves detecting block size of wall/Path zone in digital image.
- Using the block size value, digital image is mapped into a memory matrix image of cells.
- These cells are classified as Wall Cells and Open Cells (Potential Path Cells).
- In our approach, we have classified black zone as wall cell and white zone as open cell.
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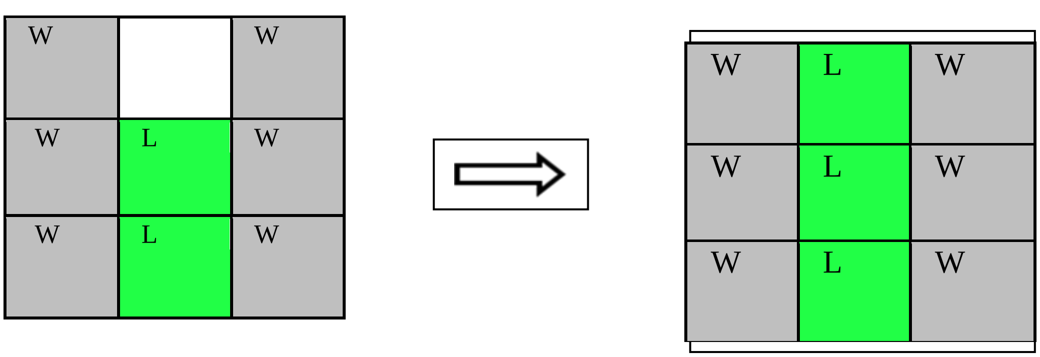
B. Cellular automata(CA):

It is a model which describes how the elements of a system combined with each other. Each element of the system is denoted as a cell. The cells can be describe as:

It may be 2-dimensional squares or 3-dimensional blocks or another shape

C. Fungal infestation technique

INFESTATION: Living cells having one or more unoccupied cells/zones will infest all of them.



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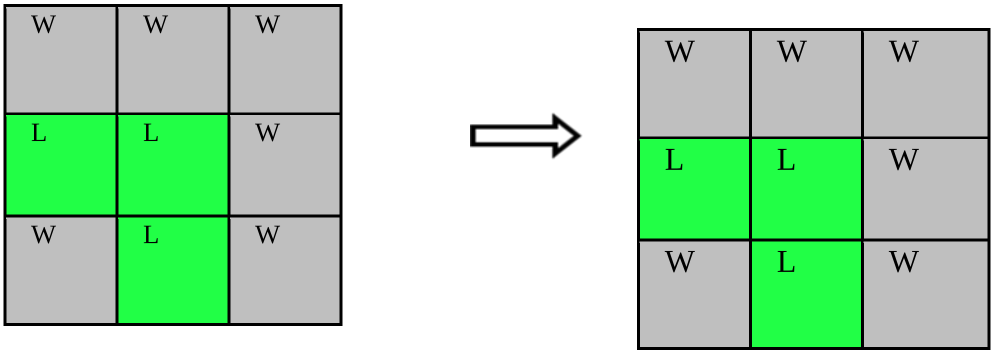
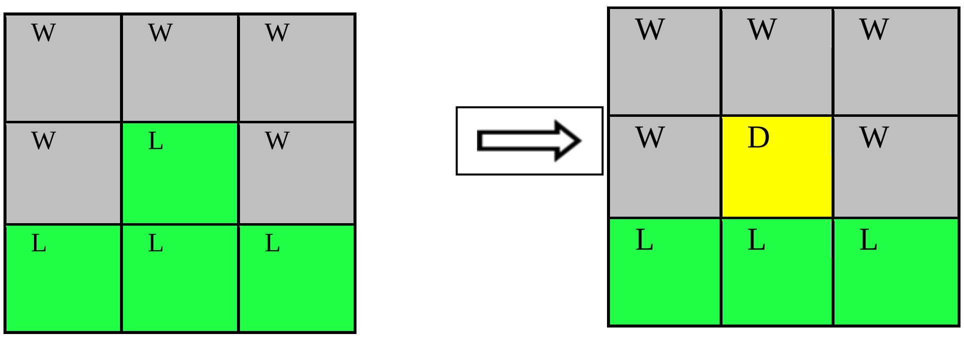
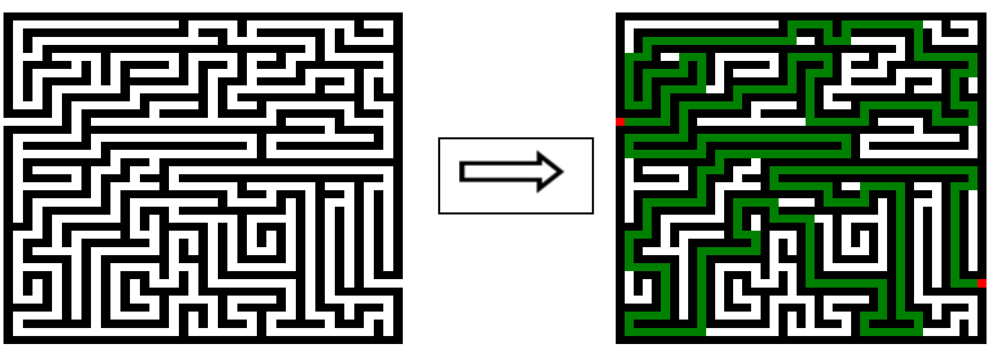
SURVIVAL:A living cell will continue to survive if it has two or more living cell neighbors



DEATH: A living cell will die if it has 3 or more dead + wall cells.



By using above three rules, our solution is in the form of:



Maze solving by Fungus Infestation using CA

- Step 1 :- Digital maze image is read from disk file and loaded into program memory.
- Step 2 :- Image is processed to detect zone block size, and start-finish points.
- Step 3 :- Image is mapped into memory matrix of cells.
- Step 4 :- Rules are applied repeatedly until system enters a stable configuration. i.e no more cell infestation, or death occurs.
- Step 5 :- Living Cells are taken note of and using memory mapping of original image.
- Step 6 :- position of living cells is traced onto original digital image. (living cell projection leads to a path which connects starting and ending point)
- Step 7 :- the traced image is displayed to user as result and then can be saved to disk for future reference.

III. PROS AND CONS

Pros / Advantages

- Faster Computation
- Better hardware utilization

- Selected pixels are processed (cells)

Cons/Disadvantages

- High Level Programming Language and Data Structures Involved.
- Applicable on Digital Mazes Only.
- Current Extraction Phase Limits use of digitally generated maze images only**.**

IV. RESULTS AND FINDINGS

Proposed approach is developed in .net C# technology and 4 sample digital mazes were tested for results.

Image Resolution (pixels)	**Block Size**	**Cell Count**	**Time Taken**
205x205 (42025)	5x5	1681	1.7 seconds
328x328 (107584)	8x8	1681	2.4 seconds
305x305 (93025)	5x5	3721	7.3 seconds
505x505 (255025)	5x5	10201	171 seconds

These results were obtained on a single core processing machine. Over a multiprocessing CA oriented machine these times will be significantly reduced in near proportion to core count.

Estimated Time = extraction time + path cell processing over n iterations + tracing time.

Extraction time includes disk file read, block size detection, memory mapping time.

n is no of iteration after which system enters a stable state. This factor is directly proportional to cell count

Tracing time includes time taken to retrieve active path cell, mapping their actual positions and tracing them onto original image to draw result image.

V. CONCLUSIONS

In a traditional maze wall cell to path cell ratio is usually 3:2. i.e. any traditional digital maze image will have roughly 60% wall pixels and 40% path pixels.

For an image of resolution 256x256, there will be 65536 pixels, for a block size of 4x4 this image can be mapped into cell matrix of 64x64=4096 cells. (~2500 wall cells, ~1600 path cells) And among all potential path cells only 10% to 30% cell contribute to path drawn.

Therefore significant improvement can be achieved by identifying cell type and processing selected cells. This simple idea used in our algorithm reduces processing time to solve digital mazes.

Theoretically a time improvement of 40-50% can be achieved over simple raster scanning algorithms by using our CA based approach to solve traditional digital images. Similar figures are reflected in sample images processed.

Thus it can be concluded that a combination of CA multiprocessing feature and selective cell based processing approach generates faster results.

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AUTHORS

First Author – Preeti Chaudhary, B.E (CSE), CSE AITM College, preeti_engg86@rediffmail.com

Second Author – Girish Garg, B.E (CSE), CSE AITM College, girish020986@gmail.com