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Building Drawing Simulation Models for the Purposes of Industrial Design

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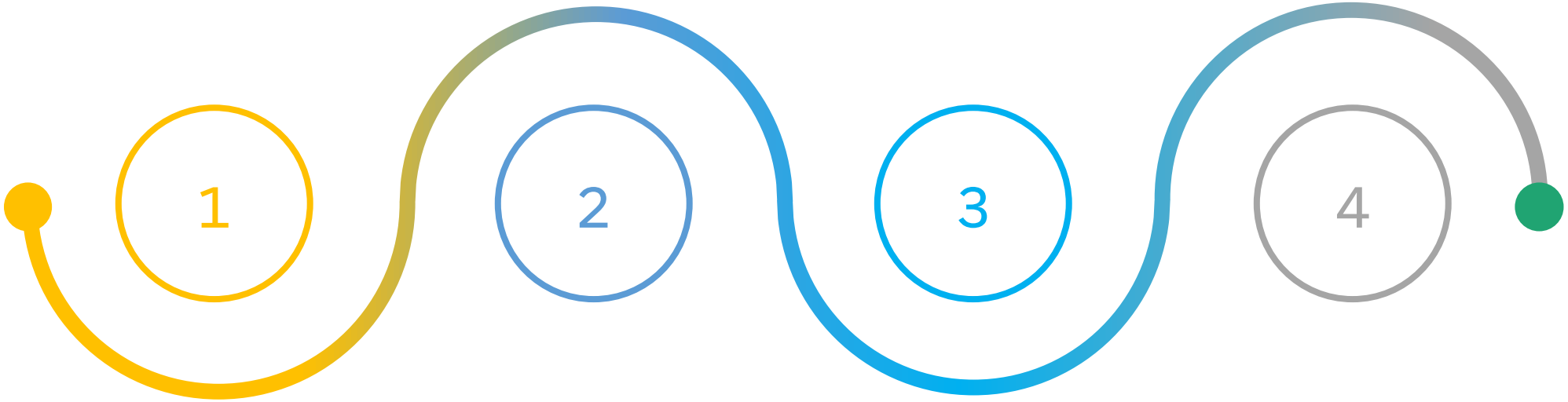
ABSTRACT



BACKGROUND

Applications of simulation modeling in computer graphics

METHOD

Agent-based modeling

AIM

Building simulation models for drawing based on the fundamental Bresenham's algorithm using NetLogo 6.2.2.

RESULTS AND CONCLUSION

Creating realistic agent-based visualization, shapes and textures for the purposes of industrial design.

INTRODUCTION

COMPUTER GRAPHICS

A powerful tool for visualizing the dynamics of complex systems and their subsystems in order to study them effectively as well as an object of simulation modelling, because of the drawing algorithms embedded in some simulation products.

SIMULATION MODELING

In agent-based modeling the movement of the agents described by a programming language can be verified by the 2D or 3D views, which represent the virtual world from the point of view of the observer.

NETLOGO 6.2.2

A suitable product to illustrate the capabilities of simulation modeling and in particular its application in the field of CG to visualize the drawing of many parallel straight lines in real time with a very short simulation duration.

CONTENT

SECTION II

Presents the background and provides a literature review.

SECTION III

Presents simulation and visualization of the Bresenham’s algorithm in NetLogo 6.2.2.

II. RELATED WORK

DLA SIMPLE EXTENSIONS 1, 2 AND 3 MODELS

They “demonstrate diffusion-limited aggregation, in which particles moving (diffusing) in random trajectories stick together (aggregate) to form beautiful treelike branching fractal structures”, which are available in nature like different crystal structures.

INPUT PARAMETERS

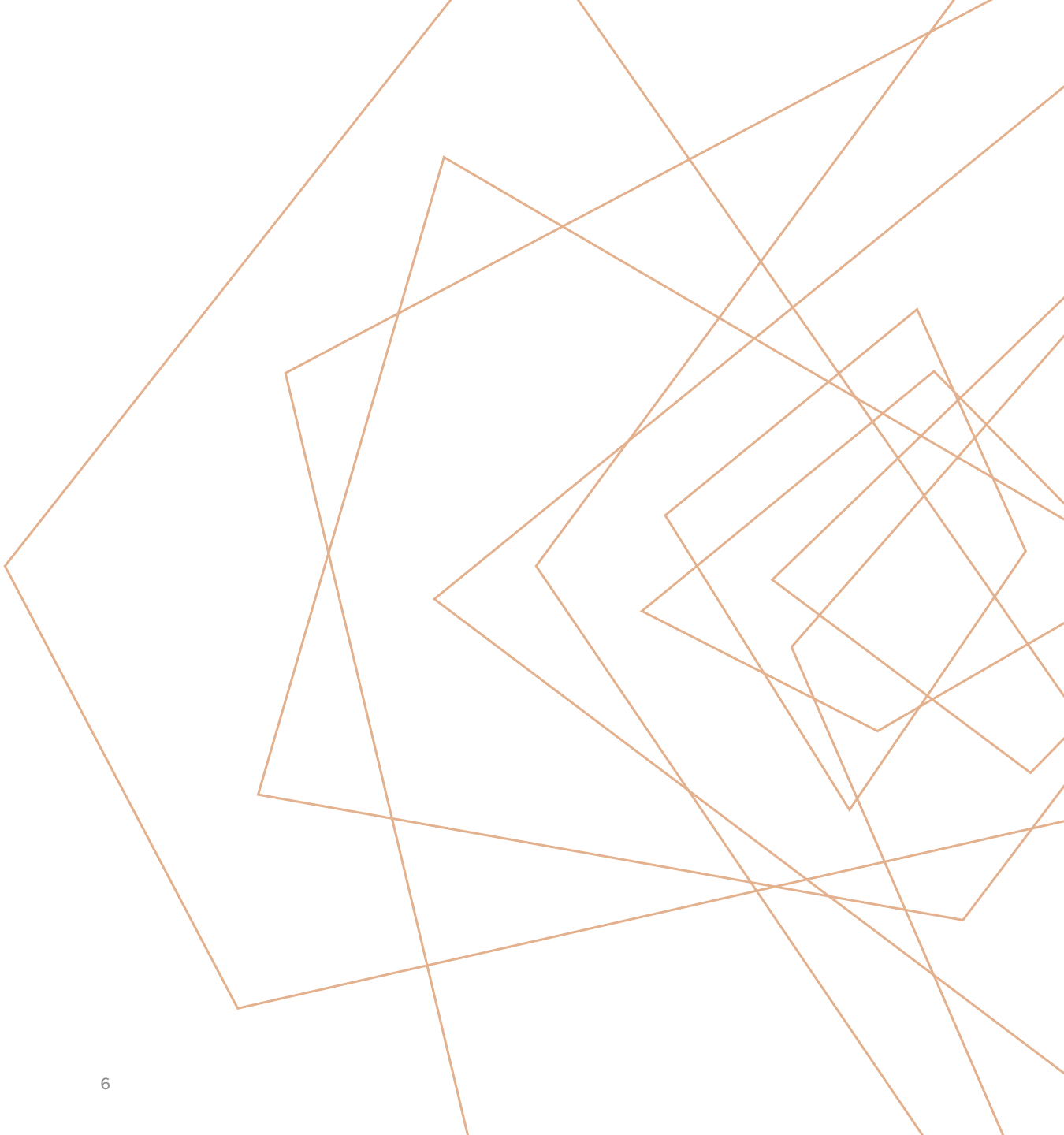
The main input parameters in the reference simulation models and after their modification by the author according to recommended criteria.

VISUALIZATIONS

The results obtained in the reference models and after their extension

JUSTIFICATION

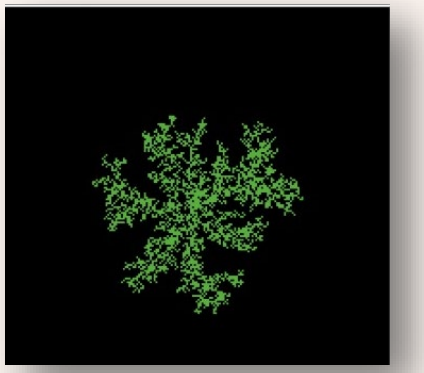
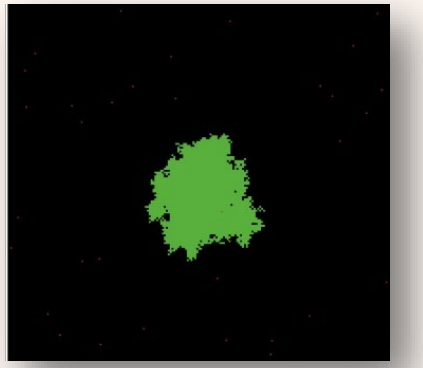
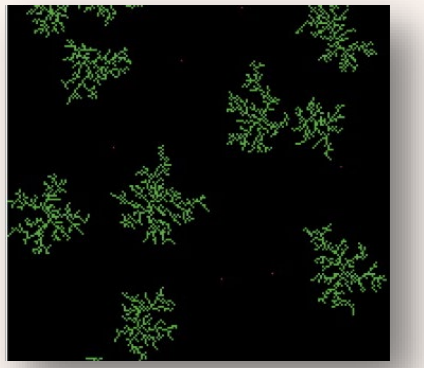
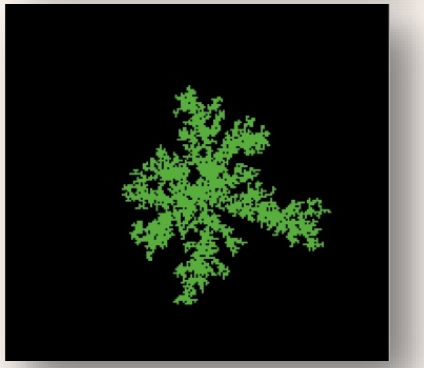
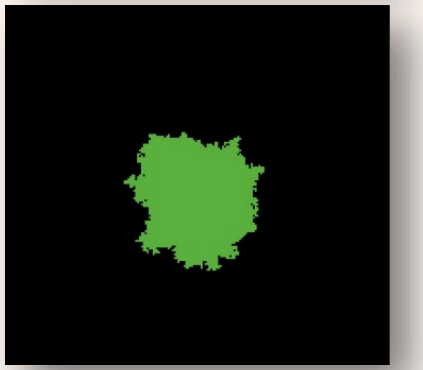
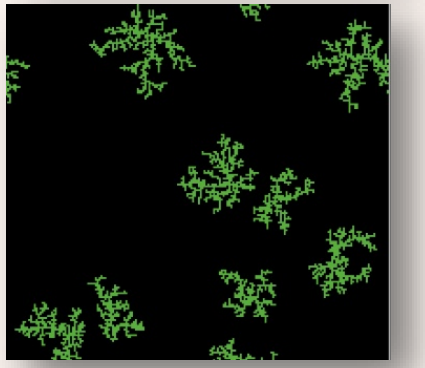
This analysis contributes to extending the overall research described in this paper because all DLA models and the model proposed by the author in Section III have different applications in the same field of CG and can complement each other depending on the aims and objectives set.



INPUT PARAMETERS IN THE REFERENCE AND EXTENDED DLA MODELS

	Criterion	DLA Simple Extension1	DLA Simple Extension2	DLA Simple Extension3
Reference model	Number of “seed” patches	1	1	10
	Neighboring patches	neighbors	neighbors	neighbors
	Wiggle-angle	60°	60°	60°
	Number of particles	2500	2500	2500
	Probability-of-sticking	0.5	0.5	1
Extended model	Number of “seed” patches	2	2	10
	Neighboring patches	neighbors4	neighbors4	neighbors4
	Wiggle-angle	100°	100°	100°
	Number of particles	3500	3500	3500
	Probability-of-sticking	0.5	0.5	1

VISUALIZATIONS OF THE SAMPLE MODELS DLA SIMPLE EXTENSION 1, 2, AND 3 BEFORE AND AFTER THEIR EXTENDING

❑ INCREASING THE NUMBER OF “SEED” PATCHES

- they can have random or determined values.

❑ CHANGING THE NUMBER OF SURROUNDING PATCHES

- “neighbors” means that the agent set consists of 8 surrounding patches, while “neighbors 4” includes 4 surrounding patches

❑ CHANGING THE WIGGLE-ANGLE

- there is a wiggle-angle slider in the DLA models that controls if the particles move in straight (0°) or random directions (360°).

❑ USING A DIFFERENT MAIN RULE

- the color and the number of neighbors determine if the particle sticks.

❑ PROBABILITY OF STICKING

- the color and the number of neighbors determine if the particle sticks.

III. Simulation and Visualization of the Bresenham's Algorithm in NetLogo

"WORLD"

The workspace called that can be conditionally divided into patches whose sizes are measured in pixels.

SETTINGS

- The frame rate in the simulation is 30 frames per second at normal speed.
- Pressing the "setup" button shows different directions of movement trajectories in the proposed model.

BRESENHAM'S ALGORITHM

- entering and displaying endpoints (x_1, y_1) and (x_2, y_2);
- computing $dx = x_2 - x_1$; $dy = y_2 - y_1$.
- computing the gradient (slope) $m = dx/dy$ ..

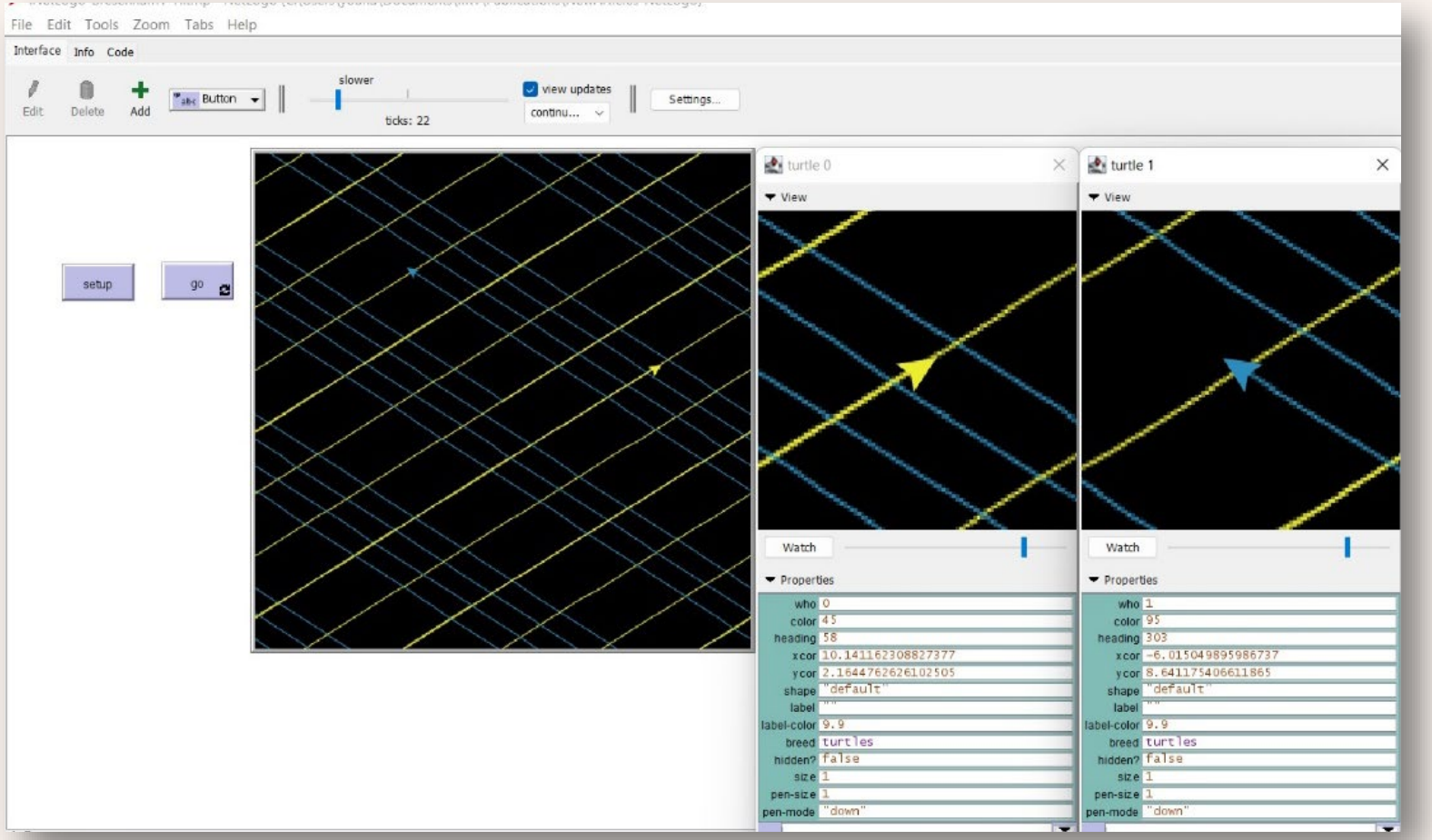
SCENARIOS

SCE 1, SCE 2, SCE 3, and SCE 4

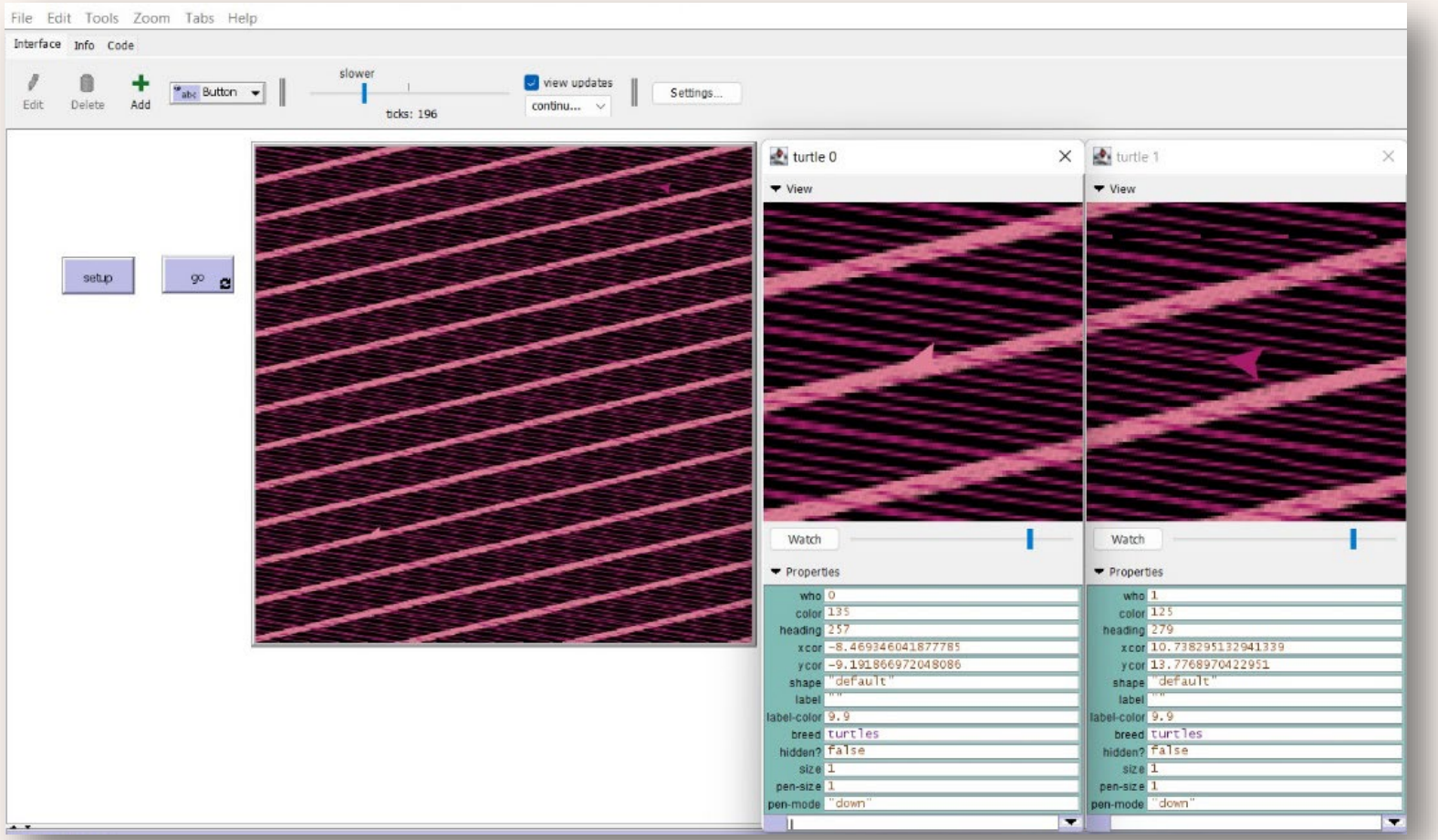
THE ACTIONS AND SPATIAL COORDINATES OF AGENTS IN FOUR SCENARIOS

		SCE 1	SCE 2	SCE 3	SCE 4
Actions of agents		T_0 moves straight T_1 moves straight and draws	T_0 moves straight and draws T_1 moves straight	T_0 moves straight and draws T_1 moves straight and draws	T_0 moves back and draws T_1 moves back and draws
SSC (x_1, y_1)	T_0	(0, 0)	(0, 0)	(0, 0)	(0, 0)
	T_1	(0; 0)	(0, 0)	(0, 0)	(0, 0)
RSSC (x_2, y_2)	T_0	(10.53, -10,56)	(0, -7)	(9.82, 1.91)	(15, 0.26)
	T_1	(-12.59, 15.54)	(-1.4, -6.98)	(9.87, 0.52)	(5.13, -14)

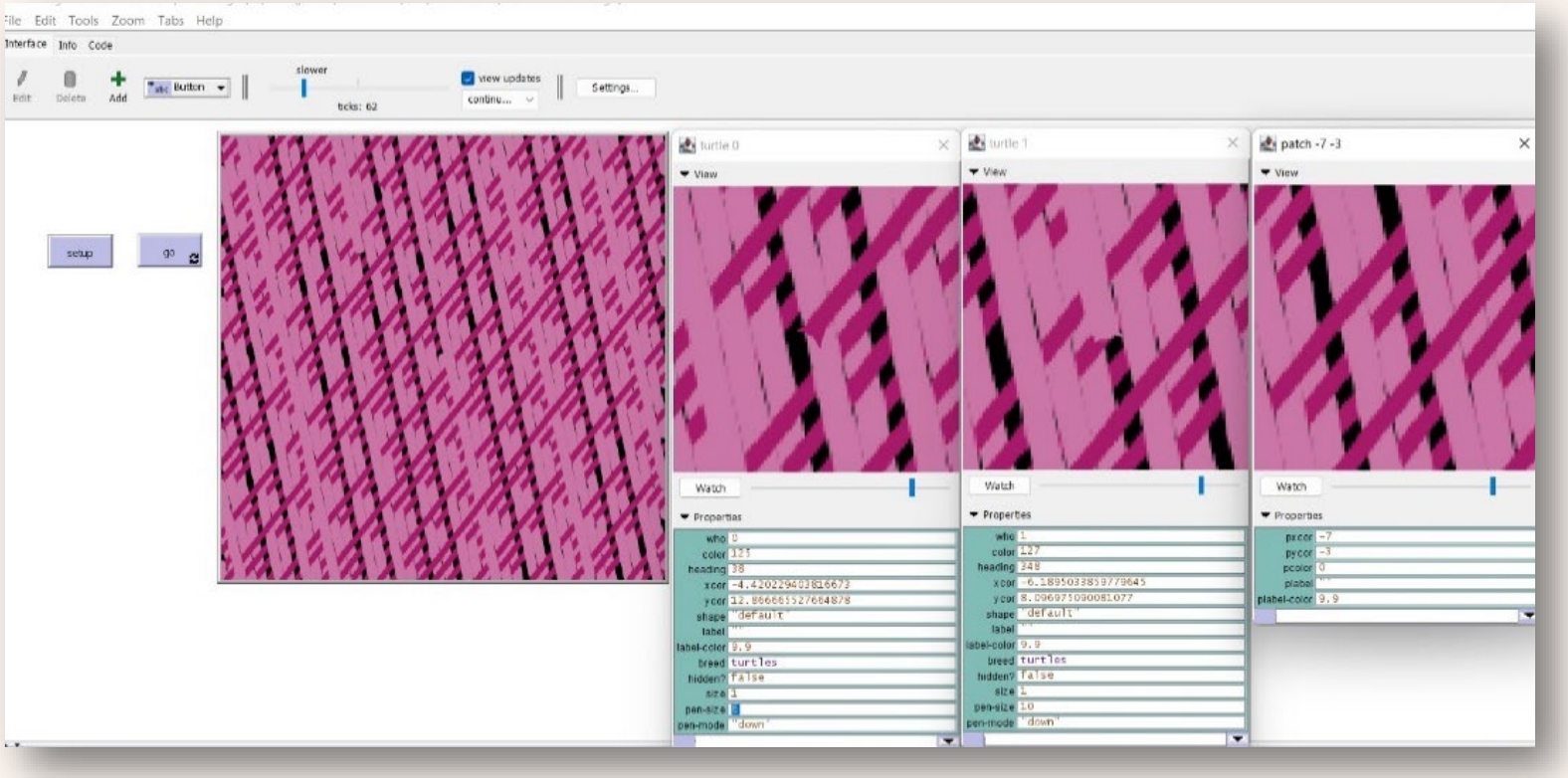
A visualization of drawing diagonal lines by T_0 and T_1 in SCE 3



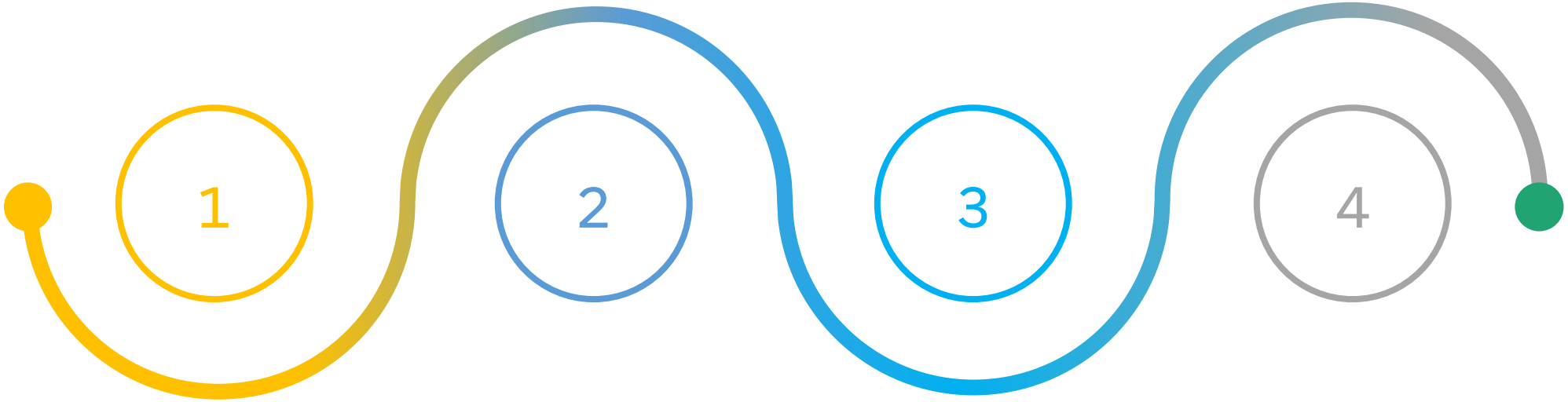
A visualization of drawing diagonal lines by T_0 and T_1 in SCE 4



A visualization of drawing lines by T_0 and T_1 in SCE 4



A. ASSESSMENT AND ANALYSIS OF THE SIMULATION RESULTS



VISUALIZATION

An extended summary evaluation of the experimental results obtained can be made based on the visual information.

SETTINGS

- The “tick counter” entered measures the elapsed model time in ticks.
- the two agents move and draw with the same steps.

COMMANDS

Two commands that are analogous in their meaning – “jump” and “forward”.

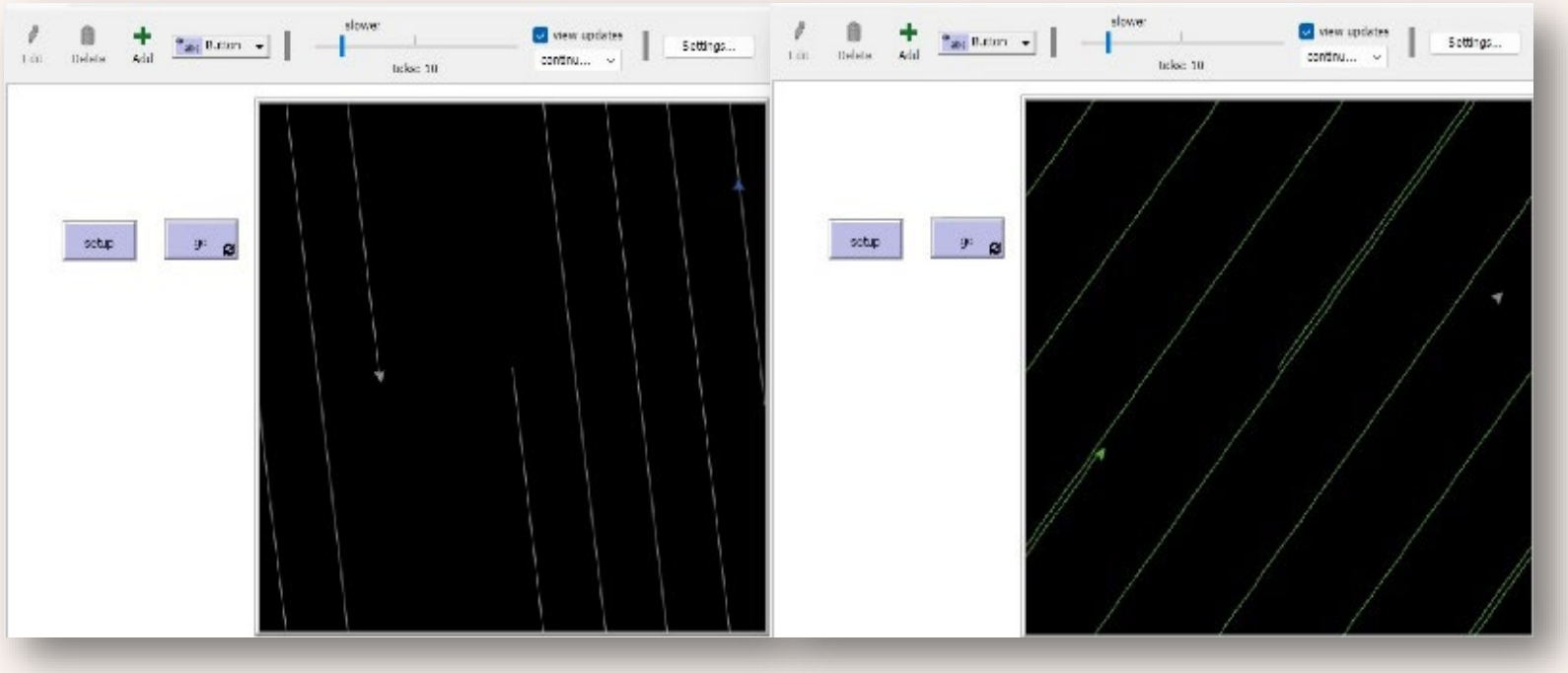
CRITERION

The number of lines drawn when the tick is equal.

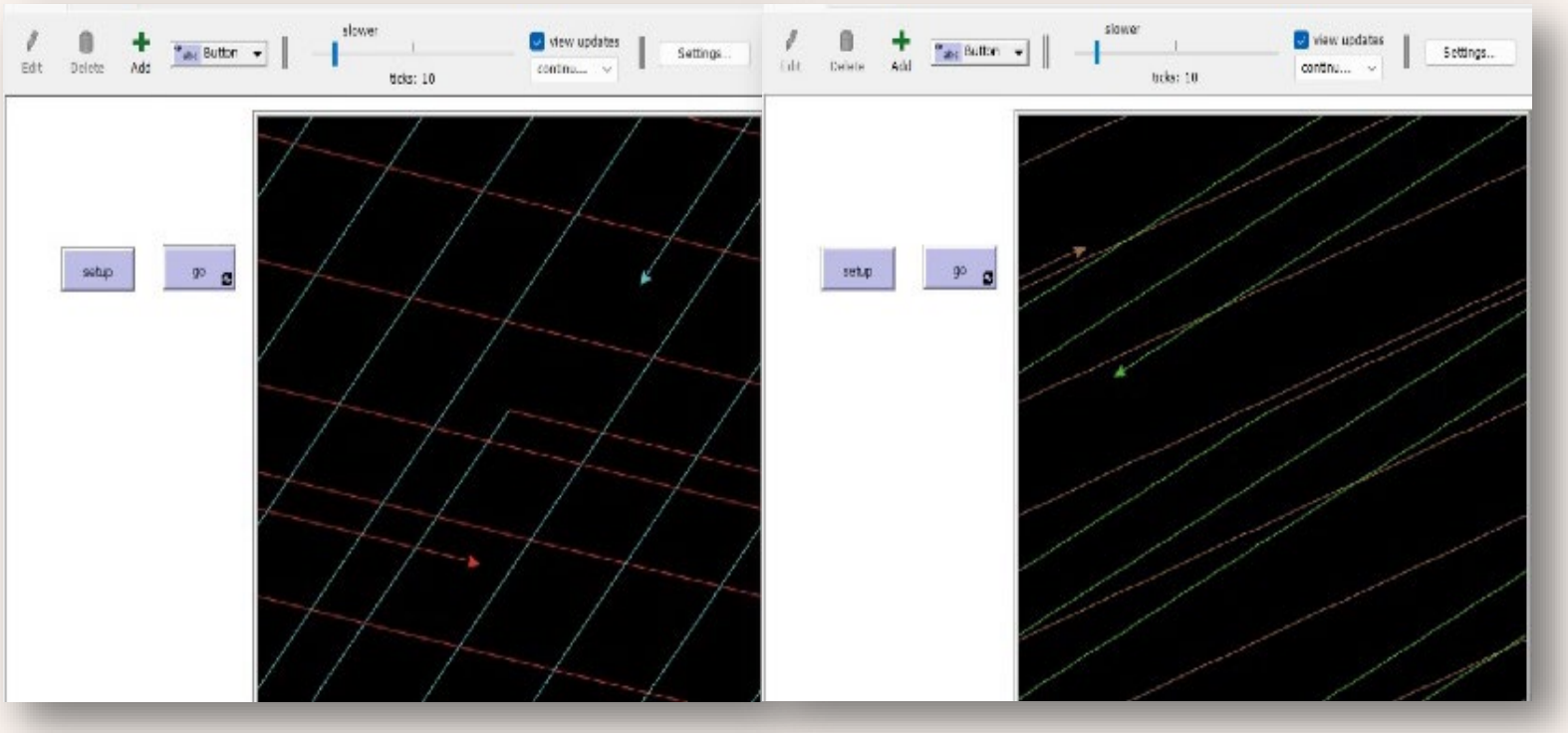
INPUT PARAMETERS IN CASE OF USE OF TWO ANALOGOUS COMMANDS

Scenarios	Command		Tick	Number of lines
SCE 1	jump	5	10	2
		20		8
	forward	5		3
		20		10
SCE 3	jump	5		4
		20		17
	forward	5		6
		20		17

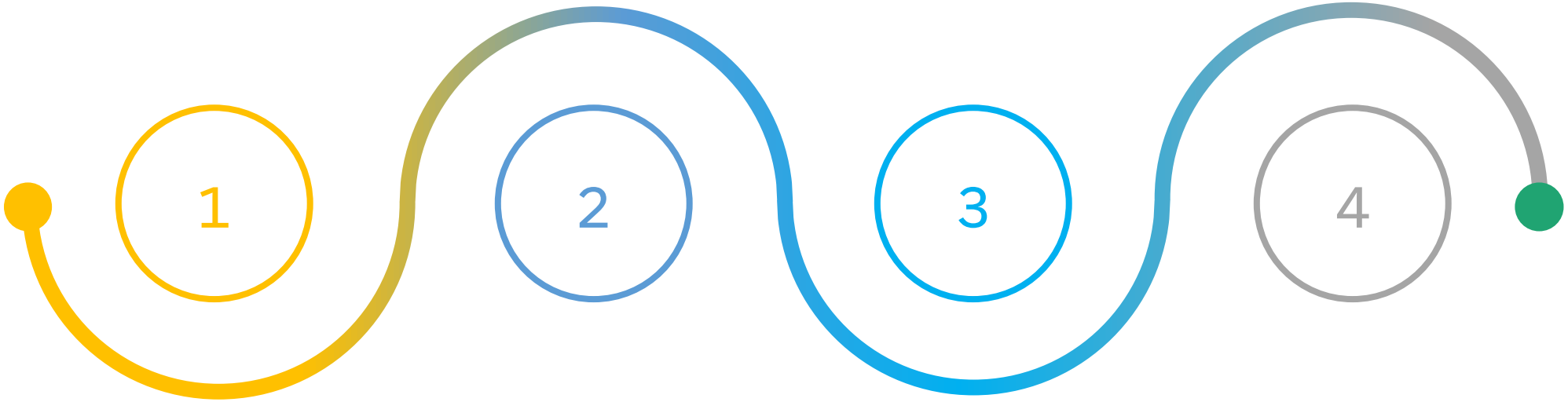
A comparative analysis between the results in SCE 1 if “jump 20” (left) or “forward 20” (right) are used



A comparative analysis between the results in SCE 3 if “jump 20” (left) or “forward 20” (right) are used

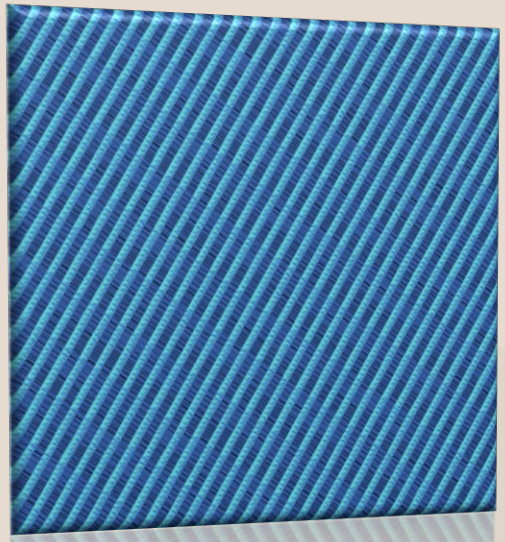


B. APPLICATIONS OF THE SIMULATION RESULTS IN INDUSTRIAL DESIGN



1. airline interior styling
2. automobile design
3. sports equipment and safety clothing design
4. furniture reproduction

TEXTURES OBTAINED FROM THE SIMULATION



3D OBJECTS TEXTURED WITH IMAGES OBTAINED FROM THE SIMULATION

ADVANTAGES OF THE SIMULATION MODEL

CREATING TEXTURE MAPS FOR 3D MODELS

A great variety of an average of 40 structures that can be generated automatically during the simulation lasting less than a minute by only changing a few basic settings (color, line thickness, the direction of movement, and the number of agents).

POSSIBILITY OF UPGRADING

From a practical point of view, the extension itself can be expressed both in increasing the number of agents, and in embedding them in a complex model with a similar or completely different purpose.

EXPERT GUIDANCE

The overall process of simulation modeling takes place with the participation of an expert who develops or modifies a conceptual model, sets the input parameters of the simulation, checks and validates the model, and - evaluates and analyzes the generated results.

REFERENCES

[1] M. A. Rovbo, E.E. Ovsyannikova, Simulating robot groups with elements of a social structure using KVORUM, 6th International Young Scientists Conference in HPC and Simulation, YSC 2017, 1-3 November 2017, Kotka, Finland, pp. 147-156.

[2] U. Wilensky, W. Rand, Introduction to Agent-Based Modeling: Modeling Natural, Social and Engineered Complex Systems with NetLogo. Cambridge, MA. MIT Press, 2015.

[3] U. Wilensky & W. Stroup, 1999. HubNet, The NetLogo 6.3.0 User Manual, Center for Connected Learning and Computer-Based Modeling, Northwestern University. Evanston, IL. Available at: http://ccl.northwestern.edu/netlogo/hubnet.html (visited on: 28.01.2023).

[4] M. Daniel, A Mathematical Overview of Bresenham Algorithms in the Determination of Active Pixel Positions, International Journal of Innovative Research in Computer and Communication Engineering (An ISO 3297: 2007 Certified Organization) Vol. 5, Issue 10, October 2017, ISSN (Online): 2320-9801, ISSN (Print): 2320-9798.

[5] N. Carter, Introduction to the Mathematics of Computer Graphics, Chapter 3. Affine Transformations, MAA Press, Classroom Resource Materials, vol. 51; 2016, ISBN: 978-1-61444-122-9, Available at: https://nathancarter.github.io/mocg/site/chapter-3-resources/ (visited on: 04.02.2023).

[6] K. Kalchev, K. Tsvetkov, Kibersigurnost, Voenna akademia „Georgi Stoykov Rakovski“, Sofia, 2022, ISBN 978-619-7478-90-7, p. 38.

[7] V. Radkov, V. Alexandrova, A. Guncheva, Some Aspects in Using Unnamed Aerial Vehicles For Disasters and Crisis Response Operations, International Scientific Conference12 – 14 November, 2019, Long-term Security Environment Challenges and Armed Forces Capabilities Development (Part II), National Defence College „Georgi Stoikov Rakovski“, Sofia, 2019, ISBN 978-619-7478-35-8.

THANK YOU!

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