

Ministry of Education and Science of Ukraine

*Odessa National Academy  
of Food Technologies*



**International Competition of Student Scientific Works**

**BLACK SEA SCIENCE 2021**

**Information Technology, Automation and Robotics**

**Proceedings**

Odessa, ONAFT 2021

**UDC 004.01/08**

**Editorial board:**

**Prof. B. Iegorov**, D.Sc., Rector of the Odessa National Academy of Food Technologies, Editor-in-chief

**Prof. M. Mardar**, D.Sc., Vice-Rector for Scientific and Pedagogical Work and International Relations, Editor-in-chief

**Dr. S. Kotlyk**, Ph.D., Assoc. Prof., Director of the P.M. Platonov Educational-Scientific Institute of Computer Systems and Technologies “Industry 4.0”, Editor-in-chief

**O. Sokolova** – Senior Lecturer of the Department of Information Technology and Cybersecurity, ONAFT, Technical Editor

**Black Sea Science 2021:** Proceedings of the International Competition of Student Scientific Works. Information Technology, Automation and Robotics. / Odessa National Academy of Food Technologies; B.Yegorov, M. Mardar, S.Kotlyk (editors-in-chief.) [*et al.*]. – Odessa: ONAFT, 2021. – 526 p.

These materials of International Competition of Student Scientific Works «Black Sea Science 2021» contain the works of the contest participants in the section «Information technologies, automation and robotics» (not winners).

The author of the work is responsible for the accuracy of the information.

Odessa National Academy of Food Technologies, 2021

**Organizing committee:**

**Prof. Bogdan Iegorov**, D.Sc., Rector of Odessa National Academy of Food Technologies, Head of the Committee

**Prof. Maryna Mardar**, D.Sc., Vice-Rector for Scientific and Pedagogical Work and International Relations of Odessa National Academy of Food Technologies, Deputy Head of the Committee

**Prof. Stefan Dragoev**, D.Sc., Vice-Rector for Scientific Work and Business Partnerships of University of Food Technologies (Bulgaria)

**Prof. Baurzhan Nurakhmetov**, D.Sc., First Vice-Rector of Almaty Technological University (Kazakhstan)

**Prof. Mircea Bernic**, Dr. habil., Vice-Rector for Scientific Work of Technical University of Moldova (Moldova)

**Prof. Jacek Wrobel**, Dr. habil., Rector of West Pomeranian University of Technology (Poland)

**Prof. Michael Zinigrad**, D.Sc., Rector of Ariel University (Israel)

**Dr. Mei Lehe**, Ph.D., Vice-President of Ningbo Institute of Technology, Zhejiang University (China)

**Prof. Plamen Kangalov**, Ph.D., Vice-Rector for Academic Affairs of “Angel Kanchev” University of Ruse (Bulgaria)

**Dr. Alexander Sychev**, Ph.D., Assoc. Professor of Sukhoi State Technical University of Gomel (Belarus)

**Dr. Hanna Lilishentseva**, Ph.D., Assoc. Professor, Head of the Department of Merchandise of Foodstuff of Belarus State Economic University (Belarus)

**Prof. Heinz Leuenberger**, Ph.D., Professor of the Institute of Ecopreneurship of University of Applied Sciences and Arts (Switzerland)

**Prof. Edward Pospiech**, Dr. habil., Professor of the Institute of Meat Technology of Poznan University of Life Sciences (Poland)

**Prof. Lali Elanidze**, Ph.D., Professor of the Faculty of Agrarian Sciences of Iakob Gogebashvili Telavi State University (Georgia)

**Dr. V. Kozhevnikova**, Ph.D., Senior Lecturer of the Department of Hotel and Catering Business of Odessa National Academy of Food Technologies, Secretary of the Committee

**The jury for the section  
«Information technologies, automation and robotics»**

***Head of the jury:***

**Sergii Kotlyk** – Ph.D., Associate Professor, Director of the P.M. Platonov Educational-Scientific Institute of Computer Systems and Technologies “Industry 4.0” of Odessa National Academy of Food Technologies (Ukraine)

***Members of the jury:***

**Piotr Artiemjew** - Dr hab., Associate Professor in Decision Systems of the Faculty of Mathematics and Computer Science, University of Warmia and Mazury in Olsztyn (Poland)

**Francisco Antonio Augusto** – Dr., International Relations Manager of Higher Institute of Information and Communication Technologies (Angola)

**Andrey Kuprijanov** – Ph.D., Associate Professor of the Department of Software for Computers and Automated Systems of Belarusian National Technical University (Belarus)

**Simon Milbert** – Vice-President of Xtra Information Management, Inc. (USA)

**Ivan Palov** – D.Sc., Professor of University of Ruse “Angel Kanchev” (Bulgaria)

**Degla Gérard Hugues** – Communications and Training Manager of “MAPCOM solutions informatiques” company group (Benin)

**Nugzar Kereselidze** - Academic Doctor of Informatics (Computer Science), Associate Professor of the Department of Natural Sciences, Mathematics, Technology and Pharmacy, Sukhumi State University (Georgia)

**Etibar Seyidzade** - Associate Professor of the Department of Computer and Information Technologies, Baku Engineering University (Azerbaijan)

**Vladimir Golenkov**, D.Sc., Professor of the Department of Intelligent Information Technologies, Belarusian State University of Informatics and Radio Electronics (Belarus)

**Zhanar Omirbekova** - Ph.D., Associate Professor of the Department of Automation and Management, Satbayev University (Kazakhstan)

**Ivan Palov** - D.Sc., Professor of the Department of Power Supply and Electrical Equipment, University of Ruse “Angel Kanchev” (Bulgaria)

**Siarhei Palavenia** - Ph.D., Associate Professor, Head of the Department of Telecommunication Systems, Belarusian State Academy of Communications (Belarus)

**Alexander Goloskokov** - Ph.D., Professor of the Department of Software Engineering and Information Technology Management, National Technical University “Kharkiv Polytechnic Institute” (Ukraine)

**Peter Nikolyuk** - D.Sc., Professor of the Department of Computer Technology, Vasyl Stus Donetsk National University (Ukraine)

**Vladimir Palagin** - D.Sc., Professor, Head of the Department of Radio Engineering, Telecommunications and Robotics Systems, Cherkasy State Technological University (Ukraine)

**Viktor Khobin** – D.Sc., Professor, Head of the Department of Technological Processes Automation and Robotic Systems of Odessa National Academy of Food Technologies (Ukraine)

**Valeriy Plotnikov** – D.Sc., Professor, Head of the Department of Information Technology and Cybersecurity of Odessa National Academy of Food Technologies (Ukraine)

**Sergii Artemenko** – D.Sc., Professor, Head of the Department of Computer Engineering of Odessa National Academy of Food Technologies (Ukraine)

**Fedir Trishyn** - Ph.D., Associate Professor, Vice-Rector on Scientific and Educational Work, Odessa National Academy of Food Technologies (Ukraine)

**Valerii Levinskyi** – Ph.D., Associate Professor of the Department of Technological Processes Automation and Robotic Systems of Odessa National Academy of Food Technologies (Ukraine)

**Viktor Yehorov** – Ph.D., Supervisor of the Laboratory of Mechatronics and Robotics of Odessa National Academy of Food Technologies (Ukraine)

**Pavlo Lomovtsev** – Ph.D., Associate Professor of the Department of Information Technology and Cybersecurity of Odessa National Academy of Food Technologies (Ukraine)

**Yurii Kornienko** – Ph.D., Associate Professor of the Department of Information Technology and Cybersecurity of Odessa National Academy of Food Technologies (Ukraine)

**Serhii Shestopalov** – Ph.D., Associate Professor of the Department of Computer Engineering of Odessa National Academy of Food Technologies (Ukraine)

**Anatoly Galiulin** - Ph.D., Associate Professor, Acting Head of the Department of Electromechanics and Mechatronics, Odessa National Academy of Food Technologies (Ukraine)

***Secretary of the jury:***

**Oksana Sokolova** – Senior Lecturer of the Department of Information Technology and Cybersecurity of Odessa National Academy of Food Technologies (Ukraine)

## **DRONESC - A TOOL FOR DRONES DESIGN USING GENETIC ALGORITHMS**

Author: *Alexandr Vopilov*

Advisor: *Viorica Sudacevschi*

Technical University of Moldova (Moldova)

**Abstract.** *DronesC aims to develop software that will help people build and configure drones quickly and easily. We aim to apply our expertise to agriculture as well. In this paper, we provide a simulation that demonstrates the impact that drones can have in watering crops on the fields. This project utilizes Unity3D in conjunction with C# NEAT (NeuroEvolution of Augmenting Topologies) technology to successfully simulate the environment from where we can extract the necessary data.*

**Keywords:** *Drones, Agriculture, water, watering, NEAT technology, genetic algorithms, machine learning, simulation*

### **I. INTRODUCTION**

Agriculture is one of the most crucial industries to keep the world running. Therefore, we believe that it is important to continuously create new technologies to optimize agricultural processes.

We offer the opportunity to learn about genetic algorithms, neuroevolution, agricultural simulation, and integration with drones. We investigate the problem of optimizing Pesticide Spraying via Multi-UAVs Using Genetic Algorithms. Finally, we will create a simulation using the popular game engine Unity3D, using C / C++, C# for programming. Our goal is to simulate a simplified crop creation process for different kinds of crops. For example: wheat, corn, tomato, beet, etc.

The process goes something like this. First, a field is pre-created by sculpting the Terrain and then placing a variety of Assets on it. Next, a drone is placed in the field which then makes a watering flyby of our field in the runtime. Depending on the flight of the drone, we acquire a parameter of how well the field absorbed the liquid which ultimately affects the population of our crops. Using NEAT technology, our drone is able to use this data to evolve and mutate to produce better results.

At the moment, the agricultural industry is going strong. However, times are changing and new technology is developing and we should try and not fall behind. We understand that there might be some concerns in regards to automating different tasks, but just like during the industrial revolution these changes will create new opportunities for growth and prosperity to the agricultural industry.



and capability of UAVs, and the role of robotic operators in selecting and implementing specific types of tasks. This paper includes some details regarding the role and capability of robotics on a specific level. This article provides a comprehensive introduction and complete overview of the role and capability of robot operators in the production and delivery of agricultural aviation. Furthermore, the paper covers various aspects of robotics operations.

If the NEAT [6] is already training, it might be that they are already building an Artificial Neural Network and they are not yet doing anything to learn of the specific area in which they want to become more proficient. It might also be the case that they are not using the same neural network from the same time, but instead using the same neural network to work with the different populations. To learn about the locations, the pigs might be interested in looking for more information (and then infer whether they are using the same neural network to construct the artificial neural network):

It is known that this is exactly what the AI was used in this study. It was decided to create a neural evolution algorithm for drones.

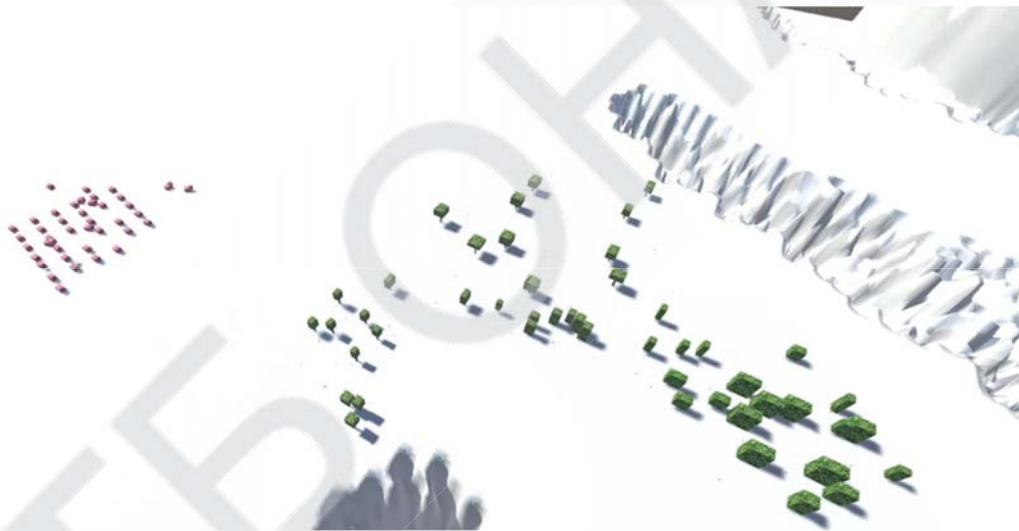


Fig. 2. Population example Unity3D

### **2.3. Drones and Agriculture**

Based on the sources [3, 7] that provide information about drones, about the use of drones, in particular agriculture, we can form certain understanding.

As mentioned earlier, the purpose of the drone is to allow farmers and other operators, to identify potential agricultural and ecological impacts through a variety of techniques. For instance, this technique can be used to map crops for harvesting, agriculture, or land use. At a low cost, it can be used for irrigation, agricultural water harvesting, and food production. Thus, aerial reconnaissance can assist farmers in identifying patterns of agricultural and environmental problems using these techniques.

Farmers are also encouraged to use satellite imagery, which can provide a detailed view and the results. These results can be used to help understand specific agricultural processes and their environment. This drone can also provide specific environmental information, and information about soil and water. The drone also comes with a special camera for monitoring the water consumption of farmers and other operators in order to help monitor changes in soil pH and the water supply of crops.

### **2.3. Big data and Machine Learning**

Based on the sources [7, 8], the researchers used machine learning to find specific species of crop under consideration. They combined this data and published a paper on the data quality that predicted crop yields in the United States. In the paper, the researchers compared the yield with all varieties (ranging from three to fifty trees varieties) in a way that could also be used to generate improved forecasts of crop production.

The results showed improvements in the yield of cultivar seeds to 70 percent while the yield for hybrid varieties had improved at nearly 10 percent. The results are clear now, but what happened to those crop yields in Iowa State? What led the scientists to conclude that genetically engineered wheat varieties could provide better yields from a variety of crops.

Although there are genetic variations in how and where to determine mutations, there are quite a many genetic and biological side effects that are not considered genetic. In some cases, there are different types of alleles. In some cases, mutations are associated with gene-receptors, where genes are associated with genotype — the genetic factors can be changed by a mutation. Genetic studies might also be used to test genetic traits.

## **III. OBJECT, SUBJECT AND RESEARCH METHODS**

We're researching drones used in, the agricultural industry through the connection of optimizations and algorithms. As an example, we study the topic of optimizing crop growth in a field depending on water irrigation. The water is watered by a drone that flies around the field. The essence of the problem is that we do not use simple machine learning algorithms, but a genetic algorithm to do this more efficiently and clearly. We use visualization to make it easier to understand how our programs work. The world is rendered using the Unity3D game engine.

What can we do if it involves a new algorithm, a new approach? Even in a new technology, improvements are limited to itself. For example, we see how our software can be simplified in our applications and will need to be built to be more accurate in our projects. However, a new approach will be needed.

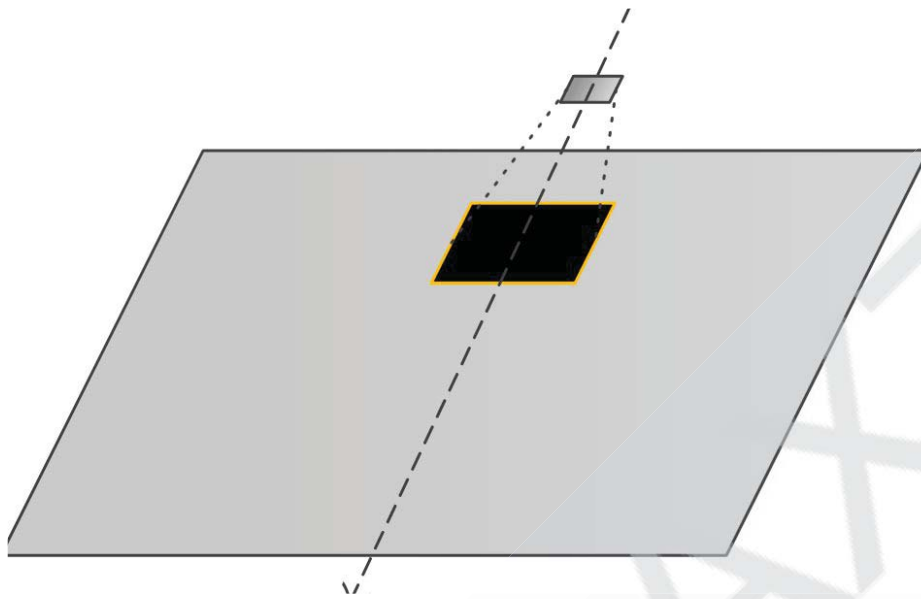


Fig. 3. The mission for drone. Gray area is a field. Black is the spraying area

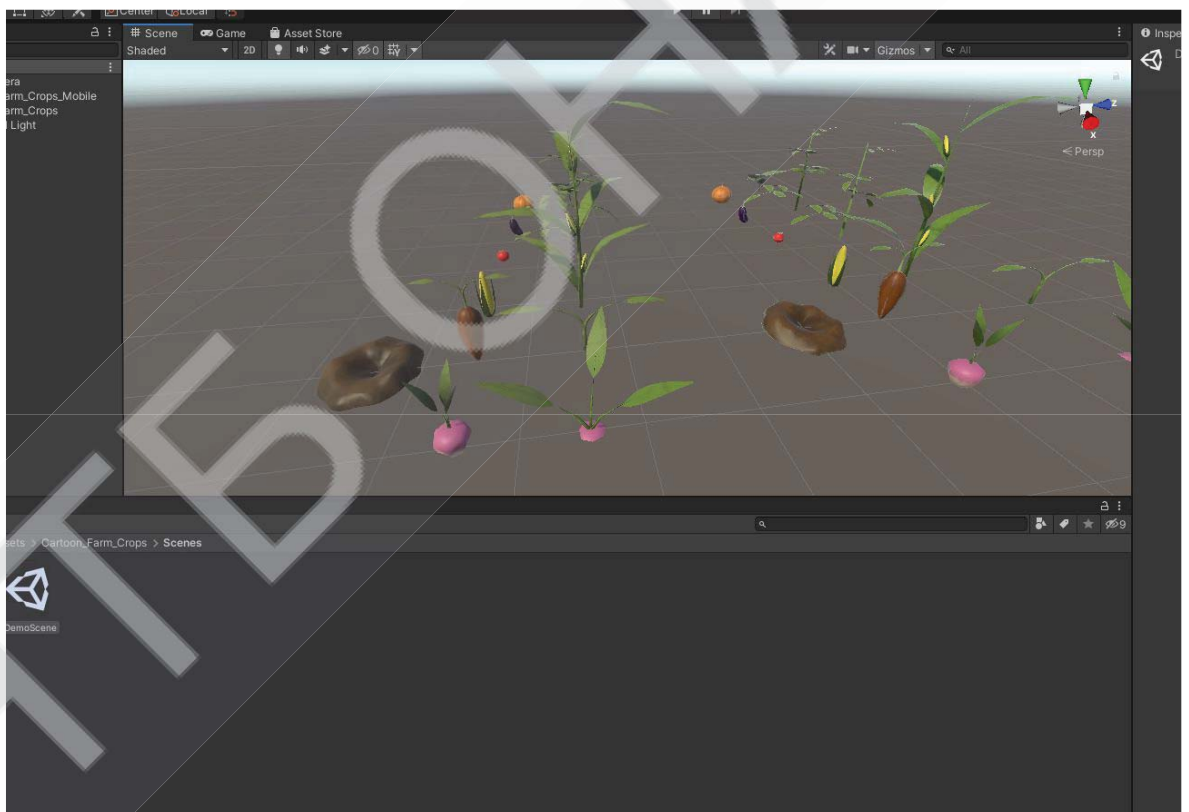


Fig. 4. Planting crops

#### IV. RESULTS

First, we create a landscape and an environment [10] that shows what this application will be about. Water is added in the form of a river so that plants and crops from the field can consume water and minerals from the soil.

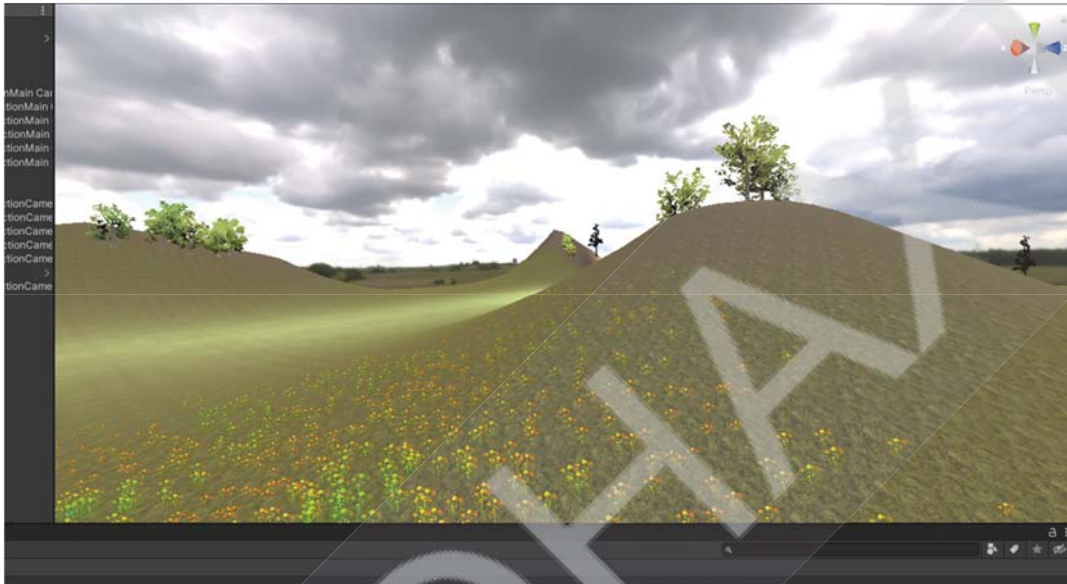


Fig. 5. Environment

As a result, a minimalistic simulation was created with a minimum of parameters for both the environment and the genetic algorithm.

Now a world (a field of cultures) is going to be created from several species. First of all, an earth hole is created so that any crop can be planted in it.



Fig. 6. A field of crops

To create a model of farms and crops, so-called assets from the Unity3D store were used. Also, from there we took textures and a 3D model of the drone.

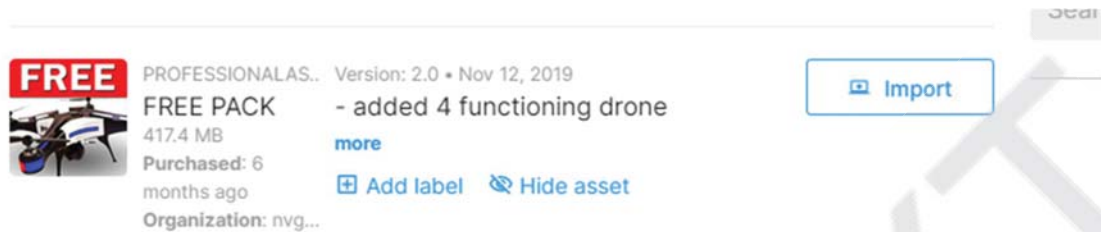


Fig. 7. Asset store

Each culture contains its own genetic code, which expresses the parameters and development of a particular plant.

Each plant has a life cycle parameter set. During this cycle, the plant must absorb a certain amount of water. The more water it has absorbed, the more resilient the population will be. When a plant decomposes, new plants are formed with different probabilities. Also, empty trenches remain on the field.

Plants have a system of reproduction. It was found that during reproduction, half of the genes are transmitted from the mother and from the father. Next, 2 descendants from the plant are formed, which turned out to be the strongest, but in this situation we made a fairly frequent intersection of genes.

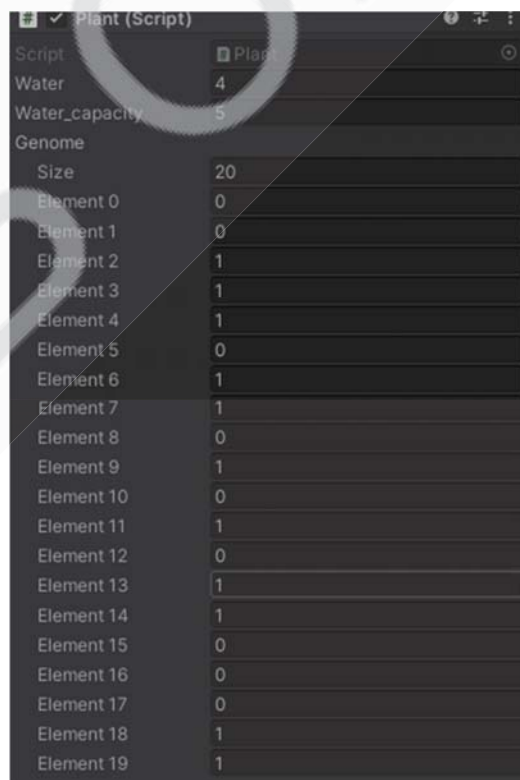


Fig. 8. Genome

So, a population of 10 plants was developed. Each of them began to evolve and mutate. Each plant consumes water, which is sprayed by the drone. Depending on the flight path and the speed of the drone, the water consumption changes. It was noticed that if the drone has a horizontal speed of about 13 m/s, then the spraying is as efficient as possible.

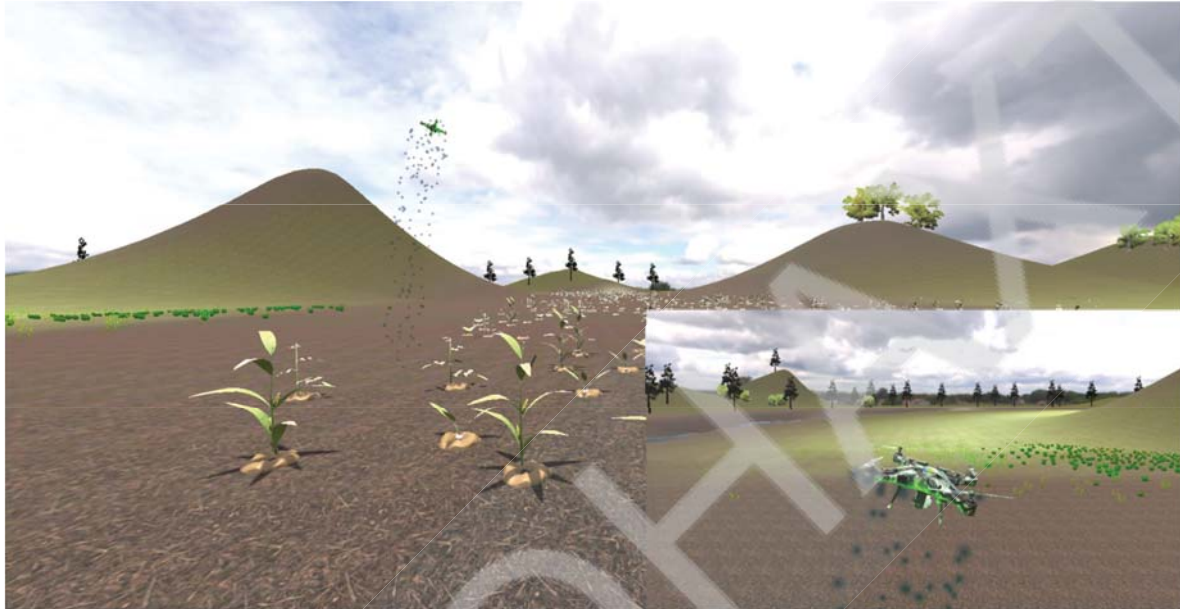


Fig. 9. The simulation

Figure 9 shows that we have a field with beet, corn, and wheat crops, as well as a flying drone that sprays water.

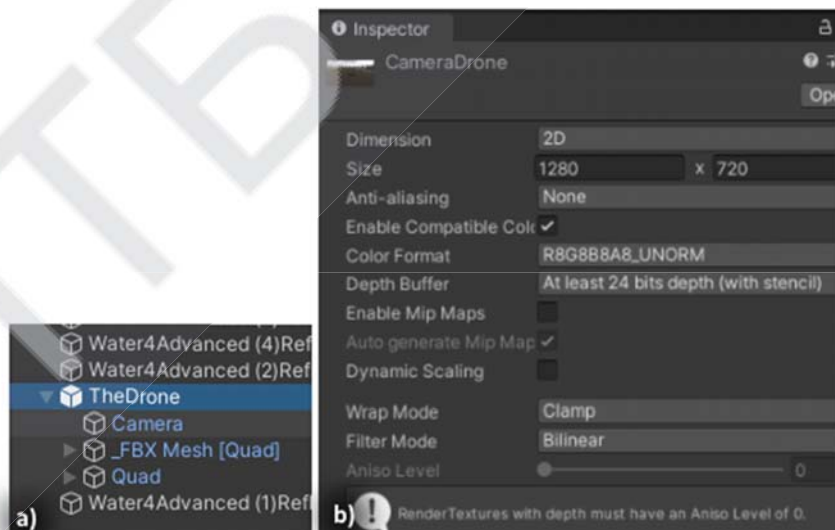


Fig. 10. a) Camera b) Render Texture

A separate camera that would monitor the flight was created (Figure 10). To

display two cameras on the screen, we made the design of the drone camera on a separate screen in the Render Texture component. The main camera is free. That is, you can fly on our field using the keyboard and mouse for a more detailed inspection of the situation.

It is logical that if our algorithm, or rather our populations, have all possible favorable conditions for development, then the situation will be as in Figure 11.

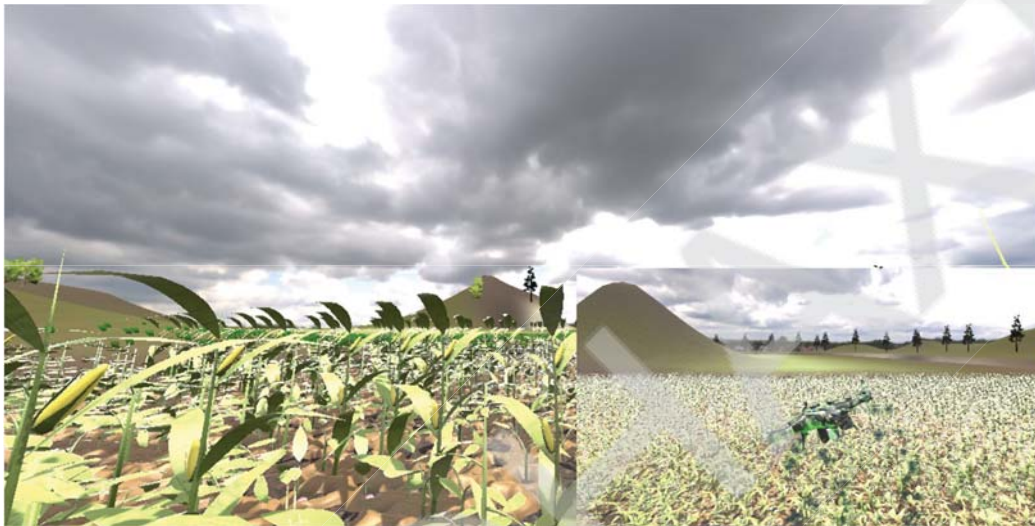


Fig. 11. Ten thousand individuals

To create a drone (Figure 12), the DJI Phantom four drone model was used. The rotation of the propeller was set by the engine power. The equation of flight and the trajectory of the drone were also given by the equations.



Fig. 12. The DJI Phantom Drone

## V. CONCLUSIONS

To sum up, we think that the experience of optimizing water spraying with a minimum amount of data from drones was a success. as it proved its dependence on the changing genes of the genetic algorithm that was used.

It is also clear that the algorithm of genetic evolution works slower, and requires more resources. However, such an algorithm is better in terms of results than other algorithms. This was revealed based on the fact that the largest amount of crop was harvested using genetic algorithm rather than when using conventional machine learning from agricultural source articles.

However, the research was conducted on minimal data and the simplest topology of both the agro system, the drone system, and the genetic algorithm. Therefore, we believe that it is mandatory to introduce new criteria and new functionality into the simulation, and then recalculate the data and results.

The entire project can be found on our github page at <https://github.com/Drones-C/ga-agro-unity>

## VI. REFERENCES

1. Silantro Flight Simulator (Forum user Oyedoyin1) Oct 30, 2016 <https://forum.unity.com/threads/released-silantro-flight-simulator.522642/>
2. Optimization of Pesticide Spraying Tasks via Multi-UAVs Using Genetic Algorithm (Yanqiu Niu, Moning Zhu, Xiaoxuan Hu, Huawei Ma, Dylan F. Jones) 12 Nov 2017 <https://www.hindawi.com/journals/mpe/2017/7139157/>
3. Drones in agriculture (Laurent Probst, Bertrand Pedersen & Lauriane Dakkak-Arnoux, PwC) January 2018 [https://ec.europa.eu/growth/tools-databases/dem/monitor/sites/default/files/Drones\\_vf.pdf](https://ec.europa.eu/growth/tools-databases/dem/monitor/sites/default/files/Drones_vf.pdf)
4. A framework and simulator for UAV air traffic integration, control, and communication (Amjed Al-Mousa, Belal H Sababha, Nailah Al-Madi Amro Barghouthi1 and Remah Younis) October 2019 <https://journals.sagepub.com/doi/pdf/10.1177/1729881419870937>
5. DEVELOPMENT OF FLIGHT SIMULATION EDUCATIONAL GAME (VALENTINA PAUNOVIC, TATJANA GVOZDENOVIC, RADOSLAV STOJIC) 29 September 2016 <https://econference.metropolitan.ac.rs/wp-content/uploads/2016/10/06-Valentina-Paunovic-Tatjana-Gvozdencovic-Radoslav-Stojic-Development-of-flight-simulation-educational-game.pdf>
6. Example of NEAT implementation (Alvin Sartor) 2017 <https://connect.unity.com/p/example-of-neat-implementation>
7. How Big Data Analytics Are Impacting the Agriculture Industry (Kayla Matthews) August 30, 2019 <https://www.vxchnge.com/blog/data-centers-analytics-and-agriculture>
8. Genetic Algorithms in Machine Learning (Jonathan Shapiro) September 20, 2001 [https://link.springer.com/chapter/10.1007%2F3-540-44673-7\\_7](https://link.springer.com/chapter/10.1007%2F3-540-44673-7_7)
9. STUDENT RESEARCH PROJECT ON PHYSICAL SIMULATIONS IN UNITY3D GAME ENGINE (M. Buszewicz, M. Plechawska-Wojcik) March 6, 2017 <https://library.iated.org/view/BUSZEWICZ2017STU>
10. Terrain (Unity Documentation) <https://docs.unity3d.com/Manual/script-Terrain.html>

**TABLE OF CONTENTS**

<b>DronesC - a tool for drones design using genetic algorithms.</b> Author: <i>Alexandr Vopilov</i> , Advisor: <i>Viorica Sudacevschi</i> , Technical University of Moldova (Moldova)	10
<b>Output of data of mechanical control systems for thermal movements of steam pipelines operating at thermal power plants into a digital APCS system.</b> Author: <i>Abykenova Zarema Aydinovna</i> , Advisor: <i>Seytkanov Sabriden Seytkanovich</i> , Academician K. I. Satpayev Ekibastuz Engineering and Technical Institute (Republic of Kazakhstan)	20
<b>Education Capsules Project.</b> Author: <i>Yurii-Ihor Syrotynskyi</i> , Advisor: <i>Vasyl Lytvyn</i> , Lviv Polytechnic National University (Ukraine)	31
<b>Decision support system for calculating the optimal provision of residents of small towns with drinking water in extreme cases.</b> Author: <i>Olexij Zakabula</i> , Advisor: <i>Oleksandr Melnykov</i> , Donbas State Engineering Academy (Ukraine)	33
<b>Image classification of the food products.</b> Author: <i>Oleh Viniarchyk</i> , Advisor: <i>Igor Malyk</i> , Chernivtsi National University (Ukraine)	45
<b>Use of neural networks to maximize the effectiveness of Shot putters training.</b> Author: <i>Kadatskyi Mykyta</i> , Advisor: <i>Oleksandr Melnykov</i> , Donbass State Engineering Academy (Ukraine)	51
<b>Implementation of image processing and output using digital filters using FPGA.</b> Author: <i>A. A. Mukhanbet</i> , Advisors: <i>Y. S. Nurakhov</i> , <i>T. S. Imankulov</i> , Kazakh National University named after Al-Farabi ( Almaty, Kazakhstan)	62
<b>The system of photo, video recording of the railway wagon weighing process.</b> Authors: <i>Karalina Dubitskaya</i> , <i>Katsiaryna Bondar</i> , Advisor: <i>Denis Demenkovets</i> , Belarusian State University of Informatics and Radioelectronics (Belarus)	72
<b>Information and analytical resource of the scientific journal " Problems of infocommunications».</b> Author: <i>Leonid Lazuta</i> , Supervisor: <i>Olga Ryabychina</i> , Belarusian State Academy of Communications (Belarus)	78
<b>Information and communication technologies as a means of organizing training of future technical specialists.</b> Authors: <i>Dmytro Tsarenko</i> , <i>Oleksandra Greenberg</i> , Advisors: <i>Volodymyr Umanets</i> , <i>Liudmyla Shevchenko</i> , Vinnytsia Mikhaïlo Kotsiubynskyi State Pedagogical University, (Ukraine)	82
<b>Development of a recommendation system.</b> Author: <i>Valeryia Runets</i> , Advisor: <i>Vadzim Sakovich</i> , Belarusian State University (Belarus)	101
<b>Guitar Tuner for Android OS.</b> Author: <i>Andrii Andriichuk</i> , Advisor: <i>Vasyl Lazoryk</i> , Yuri Fedkovych National University (Ukraine)	114
<b>Young's Problem and its application.</b> Author: <i>Kulesh Oleksandr</i> , Advisor: <i>Rusnak Mykola</i> , Yuriy Fedkovych Chernivtsi National University (Ukraine)	119
<b>Analysis of mixtures at laser surfacing using computer vision.</b> Author: <i>Mykhailo Kovalevskyi</i> , Advisors: <i>Dmitriy Kritskiy</i> , <i>Olha Pohudina</i> , National Aerospace	127

**International Competition of Student Scientific Works**

**BLACK SEA SCIENCE 2021**

**Information Technology, Automation and Robotics**

**Proceedings**

**Odessa National Academy of Food Technologies**

The collection includes student works of the participants of the competition, which were not included in the number of prize-winners. The texts of the competitive works are published in the form in which they were submitted by the authors. The authors of the articles are responsible for the content and form of submission of the material.

**Responsible for the issue: Sergii Kotlyk**

**Computer typesetting and layout: Oksana Sokolova**

**Odessa 2021**