JOURNAL OF MULTIDISCIPLINARY SCIENCES AND INNOVATIONS
GERMAN INTERNATIONAL JOURNALS COMPANY
ISSN: 2751-4390
IMPACT FACTOR (RESEARCH BIB) : 9,08. Academic research index

THE BEST ROBOTICS SIMULATION PROGRAMS FOR BEGINNERS: AN EXPLORATION OF TOOLS AND TECHNIQUES FOR EFFECTIVE LEARNING

Kamolaxon Haydarova Zokirjon kizi
Kokand University teacher at Department of Digital technologies and mathematics
Odinakhon Melikozieva
Student at Kokand University

Abstract: Robotics has rapidly evolved into a field of significant importance in both academia and industry. For beginners seeking to enter this dynamic field, robotics simulation programs offer a safe, cost-effective, and accessible platform to understand key concepts, design robots, and test algorithms. This paper explores the best robotics simulation programs for beginners, analyzing their features, ease of use, educational value, and accessibility. A comparative analysis of widely-used tools such as VEX Robotics, Gazebo, Webots, and Tinkercad is conducted, with survey data from 45 beginner students to assess usability and learning effectiveness. The aim is to guide beginners in selecting the most suitable simulation program for their specific needs and learning goals.
Keywords: Robotics simulation, Beginners, Tinkercad, VEX Robotics, Gazebo, Webots, Educational tools, Robot programming, Simulation software, Virtual environments

Introduction

Robotics is a multidisciplinary field that combines principles from mechanical engineering, computer science, and electrical engineering. For many beginners, physical robots can be costly and complex to work with, which makes simulation software a valuable learning tool. Robotics simulators provide virtual environments that mimic real-world scenarios, enabling beginners to experiment with robot design and algorithms without the need for expensive hardware.

The purpose of this thesis is to evaluate the best robotics simulation programs for beginners. The selection criteria focus on ease of use, educational value, accessibility, and community support, aiming to help newcomers select the right tool for learning.

Robotics is an interdisciplinary field combining mechanical engineering, computer science, and electronics. While robotics continues to advance rapidly, beginners often face challenges due to the high cost of hardware and the complexity of building physical robots. Robotics simulators offer an effective alternative, providing safe and accessible environments to design, program, and test robots virtually. This study aims to evaluate beginner-friendly robotics simulation software to help learners and educators identify tools that balance ease of use, educational value, and scalability for advanced robotics learning.

This study involves a comparative analysis of different robotics simulation programs, providing an in-depth review based on firsthand experience, expert opinions, and user feedback from online communities.

Overview of Robotics Simulation Software

Robotics simulation software allows users to create, test, and modify robots in a virtual environment. This eliminates the risk and expense of physical trials while providing a platform for learning, prototyping, and refining robotic systems.

Categories of Simulation Tools:

1. General Robotics Simulators: Software that caters to a broad range of robotics applications (e.g., Gazebo, Webots).

2. Educational Simulators: Tools designed specifically for beginners and educators (e.g., Tinkercad, VEX Robotics).
3. Specialized Simulators: Programs focused on specific types of robotics (e.g., industrial robots, drones).

Key Robotics Simulation Programs for Beginners

Tinkercad: Tinkercad is a browser-based 3D design and simulation tool. It offers a beginner-friendly interface that allows users to design circuits, 3D models, and simple robots.

- Easy drag-and-drop interface.
- Provides virtual simulation for Arduino-based robots.
- Integration with 3D printing and electronics design.

Educational Value: Excellent for introducing robotics concepts to young learners and students with no prior experience.

VEX Robotics: VEX Robotics provides both hardware and simulation platforms, making it ideal for beginner students and educators. VEXcode VR is a web-based simulator that uses block-based programming to teach robotics.

- User-friendly programming interface (block-based).
- Virtual robots that can perform basic tasks (e.g., moving, picking objects).
- Integrated learning resources, tutorials, and challenges.

Educational Value: Provides a structured, gamified approach to learning robotics through progressive challenges and activities.

Gazebo: Gazebo is a powerful and versatile simulation tool often used in conjunction with ROS (Robot Operating System). It is suitable for both beginners and advanced users, providing realistic physics and sensor simulation.

- Realistic physics and environment modeling.
- Extensive plugin support for sensor and robot models.
- Integration with ROS for more advanced users.

Educational Value: Ideal for students who want to transition from simple simulations to more complex, real-world robotics.

Webots: Webots is a widely used simulator that supports various robot models, including wheeled robots, humanoids, drones, and more. It supports multiple programming languages such as C, Python, and Java.

- Real-time simulation with physics-based interactions.
- Extensive library of robots and environments.
- Open-source and actively developed with a strong community.

Educational Value: Well-suited for students and beginners interested in learning robot programming with a strong emphasis on practical experience.

Comparative Analysis of Robotics Simulation Programs

Ease of Use

- Tinkercad is the easiest to use, with a visual interface that allows beginners to quickly create and simulate robots.
- VEX Robotics is also beginner-friendly, thanks to its block-based programming system.
- Webots and Gazebo, while powerful, may present a steeper learning curve due to their more complex environments and support for professional-level tools.

Educational Value

- Tinkercad is great for early learning and foundational robotics concepts.

- VEX Robotics offers structured learning through gamified challenges and is ideal for educational environments.
- Gazebo and Webots provide a more advanced learning experience, preparing users for real-world applications.

Community Support

- Webots and Gazebo have active communities with extensive documentation, making them suitable for more advanced users.
- Tinkercad and VEX Robotics have strong educational resources, including tutorials and forums, helping beginners stay supported as they learn.

Conclusion and Recommendations

Summary of Findings: The best robotics simulation program for a beginner largely depends on the user's goals, the complexity of the projects, and the learning environment. For absolute beginners, Tinkercad and VEX Robotics offer the most accessible entry points with their easy interfaces and educational resources. However, for those looking to develop more advanced skills, Webots and Gazebo are excellent tools that provide realistic simulations and a deeper learning experience.

Recommendations:

- For younger learners or those just starting, Tinkercad or VEX Robotics are highly recommended.
- For individuals looking to pursue more advanced robotics or those with a background in programming, Webots and Gazebo will provide a better platform for growth.

Methods

Four widely-used robotics simulators were selected for evaluation: Tinkercad, VEX Robotics, Gazebo, and Webots. The selection criteria included:

- **Ease of use** (user interface, learning curve)
- **Educational value** (alignment with robotics curricula, practical skills)
- **Accessibility** (system requirements, cost, availability)
- **Community support** (documentation, forums)

A structured survey was conducted with 45 first-year engineering and IT students at Kokand University who used these simulators for beginner robotics projects over a two-month period. Students rated each simulator on a scale of 1 to 5 for ease of use, learning effectiveness, and overall satisfaction. Additionally, direct observations were recorded during practical lab sessions to assess challenges and engagement levels.

Results

The survey and observation results are summarised below:

Simulator	**Ease of Use (Avg)**	**Learning Effectiveness (Avg)**	**Overall Satisfaction (Avg)**
Tinkercad	4.8	4.5	4.7
VEX Robotics	4.6	4.4	4.5
Gazebo	3.2	4.1	3.5
Webots	3.5	4.3	3.8

Key Observations:

- Tinkercad and VEX Robotics were preferred by absolute beginners due to intuitive drag-and-drop/block-based interfaces.
- Gazebo and Webots were initially challenging but highly appreciated by students interested in deeper robotics programming and sensor integration.
- Students highlighted the strong educational resources of VEX Robotics, including gamified challenges.
- Several students noted that Gazebo and Webots motivated them to learn ROS and Python for advanced robotics tasks.

Discussion

The findings indicate that **Tinkercad and VEX Robotics** are excellent tools for building foundational robotics skills, offering ease of use and engaging learning experiences suitable for school and early university levels. These tools lower entry barriers by providing visual programming environments and quick feedback loops, which are essential for maintaining motivation among beginners.

Conversely, **Gazebo and Webots** offer greater realism and flexibility, which aligns well with advanced robotics learning objectives. Despite their steeper learning curves, they prepare students for real-world robotics applications, including sensor simulations, environment modeling, and integration with ROS, which were highly valued by students aiming for research or competitive robotics projects.

The survey results reflect that accessibility and ease of use are critical in the early stages of robotics learning, but as students gain confidence, tools like Gazebo and Webots can enhance their readiness for more complex robotics tasks. Educators are encouraged to adopt a tiered approach, starting with Tinkercad or VEX Robotics and gradually introducing Gazebo and Webots to align with learners' progression.

Conclusion

This study concludes that the choice of a robotics simulation program for beginners should align with learners' goals and their stage of study. **Tinkercad and VEX Robotics** are recommended for absolute beginners due to their ease of use and effective educational frameworks, while **Gazebo and Webots** are ideal for learners transitioning to advanced robotics skills. By strategically using these simulators in educational settings, educators can foster practical robotics skills while maintaining high learner engagement.

References:

1.Khatib, O., Siciliano, B., & Lombardi, M. (2017). Handbook of Robotics. Springer.
2.Siciliano, B., & Khatib, O. (2016). Springer Handbook of Robotics (2nd ed.). Springer.
3.Haydarova K. ROBOTICS: ITS IMPORTANCE AND LEVEL OF STUDY IN THE FIELD OF IT //University Research Base. – 2024. – P. 1004-1006.
4.Haydarova K. SENSORS AND ACTUATORS IN ROBOTICS. TYPES OF INFORMATION DISPLAYS //QO ‘KAN UNIVERSITY NEWSLETTER. – 2024. – T. 13. – P. 366-371.
5.Kamolakhon H. et al. WATER-SOURCE OF LIFE. OUR COUNTRY'S NEED FOR WATER AND WAYS TO PREVENT DROUGHT //Materials of the International Scientific and Practical Conference "GLOBAL RELATIONS THEORY: YOUTH'S IDEALS OF DEVELOPMENT". – 2025. – T. 1. – No. 2. – P. 27-32.
6.Kamolakhon H., Abbosjon T., Nurmatov S. DEVELOPMENT OF A DEVICE PROJECT THAT DETERMINES THE AMOUNT OF ELEMENTS THAT ENSURE SOIL FERTILITY (POTASSIUM, CALCIUM, NITROGEN) //QO ‘QON UNIVERSITY NEWSLETTER. – 2025. – T. 14. – P. 242-247.
7.Haydarova K. et al. NATURE AND US. PROBLEMS OF THE ARAL SEA //Materials of the International Scientific and Practical Conference "THEORY OF GLOBAL RELATIONS: IDEALS OF DEVELOPMENT OF YOUTH". – 2025. – Vol. 1. – No. 2. – P. 33-37.
8. Haydarova K. SOIL NPK SENSOR AND ARDUINO: INTELLIGENT MONITORING SYSTEM FOR HEALTHY PLANT GROWTH //QOKON UNIVERSITY NEWSLETTER. – 2024. – Vol. 13. – P. 390-392.