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Preface

Pioneering Educational Perspectives: Series 2025 is a collection of thought-provoking insights and research contributions exploring contemporary educational trends and practices. This eBook presents a diverse range of perspectives on innovative teaching methodologies, digital learning strategies, and transformative approaches in education. Designed to serve as a resource for educators, researchers, and practitioners, it aims to inspire meaningful discussions and advancements in the field. Through carefully curated chapters, this publication offers fresh ideas and practical solutions to enhance learning experiences in an ever-evolving educational landscape.

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A TINKERCAD-BASED APPROACH TO AMR DEVELOPMENT IN ELECTRICAL ENGINEERING

Rozi Rifin[1], Kamaru Adzha Kadiran[2*], Mohamad Zhafran Hussin[3], Nor Diyana Md Sin[4] & Ezril Hisham Mat Saat[5]

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ABSTRACT

This paper presents an innovative methodology for teaching autonomous mobile robot (AMR) development to undergraduate electrical and electronics engineering students using the Tinkercad simulator. The approach addresses key challenges in robotics education, including limited resources and the need for practical experience. The eight-phase curriculum covers circuit design, microcontroller programming, sensor integration, and autonomous navigation, leveraging Tinkercad's virtual environment for rapid prototyping and iteration. Key benefits include enhanced accessibility to quality education, improved student engagement, and development of industry-relevant skills. The methodology's novelty lies in its comprehensive integration of multidisciplinary concepts and its scalable, collaborative learning approach. It prepares students for the demands of an increasingly automated world, potentially accelerating innovation in robotics and related fields. Commercial potential spans educational technology, corporate training, and specialized hardware development. By bridging theoretical knowledge and practical application, this methodology not only enhances educational outcomes but also contributes to workforce development in high-tech industries, positioning graduates to address global challenges through robotics and automation.

KEYWORDS: Robotics Education, Autonomous Mobile Robots, Tinkercad Simulator, Virtual Prototyping, Project-Based Learning, Simulation-Based Education,

PROBLEM AND OBJECTIVE

Undergraduate robotics education encounters numerous challenges, including limited access to costly hardware, time limitations, safety issues, and insufficient preparation for industry expectations. This paper introduces an innovative approach aimed at overcoming these obstacles by instructing electrical and electronics engineering students in the development of autonomous mobile robots using the Tinkercad simulator. Key goals of this initiative involve creating a structured virtual robotics curriculum, designing hands-on projects that encompass the entire development process, and assessing the effectiveness of Tinkercad in imparting robotics concepts. Additionally, the methodology seeks to connect theoretical knowledge with practical application, enhance students' problem-solving and system integration skills, and offer a scalable, cost-effective solution for delivering high-quality robotics education. By accomplishing these objectives, this approach aspires to transform how robotics is taught within undergraduate electrical and electronics engineering programs, ultimately ensuring that students are adequately equipped to meet the challenges and seize the opportunities present in the evolving field of autonomous mobile robotics. This innovative strategy not only addresses existing gaps in education but also prepares future engineers for success in a competitive landscape.

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DESIGN DESCRIPTION

Autonomous Mobile Robots (AMRs) can navigate and perform tasks in dynamic environments without human intervention, making them a crucial focus in electrical and electronics engineering (EEE). Their development encompasses various disciplines, including sensors, actuators, control systems, and programming as represented in the Figure 1. Simulation platforms like Tinkercad enable students to visualize and test their designs before physical implementation, enhancing resource efficiency and fostering innovation. The proposed methodology is divided into five key phases: conceptualization, design, simulation and evaluation, each essential for understanding AMR complexities. In the conceptualization phase, students define the AMR's objectives and functionalities, identifying applications such as navigation or object manipulation. The design phase involves selecting appropriate components and creating electronic schematics using Tinkercad as depicted in Figure 2. The simulation phase validates designs through virtual prototyping, helping students troubleshoot circuits and program code. Finally, the evaluation phase assesses performance, reinforcing the entire design process and equipping students with vital skills for careers in automation and robotics.

VISUALS

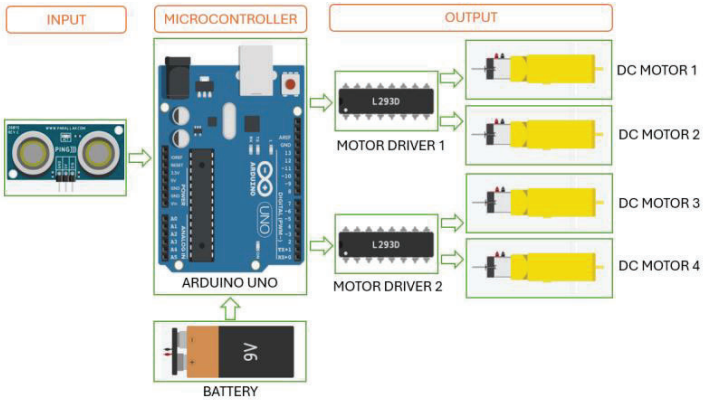


Figure 1: block diagram for AMR

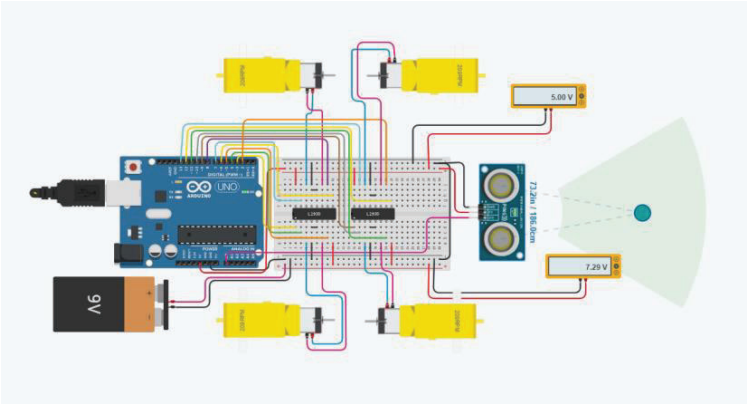


Figure 2: Autonomous Mobile Robot (AMR) simulator using Tinkercad

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NOVELTY AND UNIQUENESS

The proposed methodology for developing autonomous mobile robots using the Tinkercad simulator enhances the undergraduate learning experience with several innovative features. It offers a comprehensive virtual robotics curriculum that integrates all aspects of autonomous mobile robot (AMR) development, rather than focusing on isolated elements. This approach combines electrical engineering, programming, mechanical design, and control systems into a cohesive learning framework that reflects the interdisciplinary nature of modern robotics. Utilizing Tinkercad, a free web-based platform, ensures scalability and accessibility, democratizing high-quality robotics education for various institutions. The platform promotes real-time collaboration, allowing students to share designs and troubleshoot together, fostering peer learning. The virtual environment facilitates rapid prototyping and exploration of design options without physical constraints. Additionally, a safety-first approach enables experimentation with complex systems while minimizing risks. An adaptive difficulty scaling system caters to diverse learning needs, while an integrated assessment and feedback mechanism provides instant evaluations, collectively preparing students for future careers in autonomous systems development.

BENEFITS TO MANKIND

Implementing a comprehensive methodology for developing autonomous mobile robots with the Tinkercad simulator in undergraduate education offers numerous societal benefits. It enhances workforce preparedness by equipping students with practical skills in robotics and automation, enabling them to meet the demands of an automated world. Graduates can drive advancements in sectors like healthcare and agriculture. The free online platform democratizes access to quality education, particularly benefiting resource-limited students. Virtual prototyping reduces electronic waste and promotes environmental sustainability, while fostering safety in learning. This approach encourages interdisciplinary collaboration, lifelong learning, and prepares graduates to tackle global challenges, ultimately advancing STEM education.

COMMERCIAL POTENTIAL

The proposed methodology for developing autonomous mobile robots using the Tinkercad simulator opens various commercial opportunities. The structured curriculum can be licensed to educational institutions, providing a ready-to-use robotics program. A dedicated online platform could offer self-paced and instructor-led courses for learners and professionals. Additionally, supporting materials like textbooks and digital resources can be created. Custom Tinkercad extensions tailored for robotics education present another revenue stream. Establishing a certification program and adapting the methodology for corporate training can further enhance its reach. Virtual competitions, hardware kits for physical prototyping, and data analytics will meet the growing demand for robotics skills across industries.

CONCLUSION

This paper outlines a comprehensive methodology for developing autonomous mobile robots using the Tinkercad simulator, tailored for undergraduate electrical and electronics engineering education. It tackles significant challenges in robotics education, such as limited physical resources, safety issues, and the necessity for practical, industry-relevant skills. By leveraging Tinkercad, the methodology provides a scalable and engaging way to teach complex concepts through a structured, project-based curriculum that guides students from basic circuit design to advanced autonomous navigation. Emphasizing multidisciplinary integration, virtual prototyping, and collaborative learning within a safe environment enhances educational quality and equips students for an automated future. This approach fosters innovation, democratizes

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access to quality education, and supports workforce development in high-tech sectors, ultimately shaping future engineers and advancing robotics technology for societal benefit.

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