E-PROCEEDINGS

INTERNATIONAL TINKER INNOVATION & ENTREPRENEURSHIP CHALLENGE (i-TIEC 2025)

"Fostering a Culture of Innovation and Entrepreneurial Excellence"

23 January 2025
PTDI, UiTM Cawangan Johor
Kampus Pasir Gudang

ORGANIZED BY:

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PREFACE

It is with great pleasure that we present the e-proceedings of International Tinker Innovation & Entrepreneurship Challenge (i-TIEC 2025), which compiles the extended abstracts submitted to the International Tinker Innovation & Entrepreneurship Challenge (i-TIEC 2025), held on 23 January 2025 at **PTDI, Universiti Teknologi MARA (UiTM) Cawangan Johor, Kampus Pasir Gudang.** This publication serves as a valuable resource, showcasing the intellectual contributions on the invention and innovation among students, academics, researchers, and professionals.

The International Tinker Innovation & Entrepreneurship Challenge (i-TIEC 2025), organized under the theme "Fostering a Culture of Innovation and Entrepreneurial Excellence," is designed to inspire participants at various academic levels, from secondary students to higher education students and professionals. The competition emphasizes both innovation and entrepreneurship, encouraging the development of product prototypes that address real-world problems and have clear commercialization potential. By focusing on technological and social innovations, i-TIEC 2025 highlights the importance of turning creative ideas into viable, market-ready solutions that can benefit users and society. The extended abstracts in this e-proceedings book showcase the diverse perspectives and depth of research presented during the event, reflecting the strong entrepreneurial element at its core.

We extend our sincere gratitude to the contributors for their dedication in sharing their innovation and the organizing committee for their hard work in ensuring the success of the event and this publication. We also appreciate the support of our collaborators; Mass Rapid Transit Corporation Sdn. Bhd. (MRT Corp), Universitas Labuhanbatu, Indonesia (ULB), Universitas Riau Kepulauan, Indonesia (UNRIKA) and IEEE Young Professionals Malaysia, whose contributions have been instrumental in making this event and publication possible.

We hope that this e-proceedings book will serve as a valuable reference for researchers, educators, and practitioners, inspiring further studies and collaborations in both innovation and entrepreneurship. May the knowledge shared here continue to spark new ideas and market-ready solutions, advancing our collective expertise and fostering the growth of entrepreneurial ventures.

B-ST010 - B-ST152

B-ST048: DEVELOPMENT OF COST-EFFECTIVE ARDUINO-BASED OBJECT DETECTION AND COLOR SORTING WITH CONVEYOR SYSTEM FOR EXPERIENTIAL LEARNING IN AUTOMATION AND DIGITALIZATION

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ABSTRACT

This study presents the design and development of a cost-effective, DIY Arduino-based object detection system integrated with conveyor and actuator components, aimed at enhancing educational applications in automation and digitalization. Addressing the high costs and complexity of traditional industrial automation systems, the proposed solution leverages the accessibility and flexibility of Arduino platforms to provide an affordable and scalable tool for experiential learning. The system features an AI-driven object detection module, real-time data communication, and actuator control, simulating core functionalities of industrial setups in a classroom-friendly environment. The innovation lies in its adaptability to dynamic real-world conditions, such as variable conveyor speeds and partial object occlusions, offering students a realistic hands-on learning experience. By bridging the gap between theoretical concepts and industrial practices, this system prepares learners for the demands of Industry 4.0 while fostering technological literacy. The solution's affordability and modular design make it highly replicable for institutions with limited resources, extending its socio-economic impact by democratizing access to cutting-edge educational technologies. With potential applications in vocational training and STEM education, this system holds promise for commercialization as an educational toolkit, offering unique value to schools, training centers, and educational product developers seeking cost-efficient automation teaching aids.

Keywords: Automation Education, Arduino-Based Automation Systems, Conveyor

1. Product Description

Automation and digitalization are critical to modern industries, driving efficiency and precision. However, their integration into education for hands-on learning remains limited, particularly due to the high costs and complexity of conventional industrial systems. With the rise of Industry 4.0, which emphasizes smart manufacturing, artificial intelligence (AI), and the Internet of Things (IoT), there is a pressing need to incorporate these technologies into educational curricula. Providing practical exposure to industrial automation is essential for equipping students with the skills required to navigate increasingly automated industries. Traditional automation systems are expensive and resource-intensive, making them inaccessible for many educational institutions. Static teaching methods further fail to replicate the dynamic nature of real-world industrial scenarios. Arduino-based systems

present a cost-effective and scalable alternative, offering affordability, flexibility, and ease of use. By integrating Arduino with object detection technologies and conveyor systems, these setups simulate industrial automation processes, enabling students to engage with AI-driven object recognition, real-time data communication, and actuator control. Despite their potential, existing research rarely explores Arduino's application in education. This study addresses these gaps by developing a cost-effective Arduino-based object detection system with conveyor integration, aiming to bridge theoretical knowledge and practical expertise in automation and digitalization education. The system's adaptability and affordability promise transformative impacts on teaching and learning.

2. Project Implementation and Operation

This project integrates mechanical and electrical components in a cohesive design in order to develop an efficient and economical object detection and color sorting features a conveyor system. The system is designed to detect the material of objects, analyze their colors, sorting them into designated cases, and count them using a cost-effective Arduino-base setup. **Figure 1** illustrates the block diagram of the complete systems. The mechanical system features a durable conveyor design made with cost-effective aluminum profiles (3030 x 100cm) and custom 3D-printed components, including a sensor bracket. A stepper motor drives the rubber conveyor belt to ensure smooth and reliable operation with precise alignment. To further enhance performance, the system includes strategically placed rollers and pulleys for optimal tension control and seamless belt movement. For sorting operations, the system employs two servo motors: one to separate materials (metal or non-metal) and another to sort objects based on their color.

On the electrical part, an Arduino microcontroller serves as a core electrical system, seamlessly integrating with essential components, including motor drivers, metal sensors, color sensors, and a proximity sensor. These sensors enable precise detection, classification, and counting of objects. The power supply unit is tailored to the system's requirements, delivering 12V for stepper motors and 5V for the Arduino controllers. In order to ensure optimized functionality, the system employs two specialized controller units. An Arduino Mega acts as the main controller, integrating all sensors and coordinating system operations, while an Arduino Uno handles the stepper motor, generating steady PWM signals for smooth motion. The stepper motor is powered by a TB6600 driver, delivering reliable performance and accurate motion control. For the user's convenience, an LCD displays real-time sorting and counting data, making monitoring easy and intuitive. To prioritize safety, an emergency start and stop button is integrated into the design to immediately halt the system in the event of a malfunction, minimizing the risk of damage.

Figure 2 shows the prototype of the system. As the object passes the first metal sensor and proximity 1, the system determines their material type. Metal objects are immediately rejected and placed in a specific using a servo motor 1, while plastic objects continue traveling along the conveyor. In the second stage, a color sensor and proximity sensor 2 work together to classify the object by color. Plastic objects are sorted into two categories of color, green and red, using servo motors to direct them into their respective bins. A counter tracks the total number of sorted objects and displays this information in real time on an LCD screen for convenient monitoring. Focused on portability, simplicity and modularity, this design is

particularly suited for experiential learning in the automation and digitization field, offering flexibility and ease of assembly.

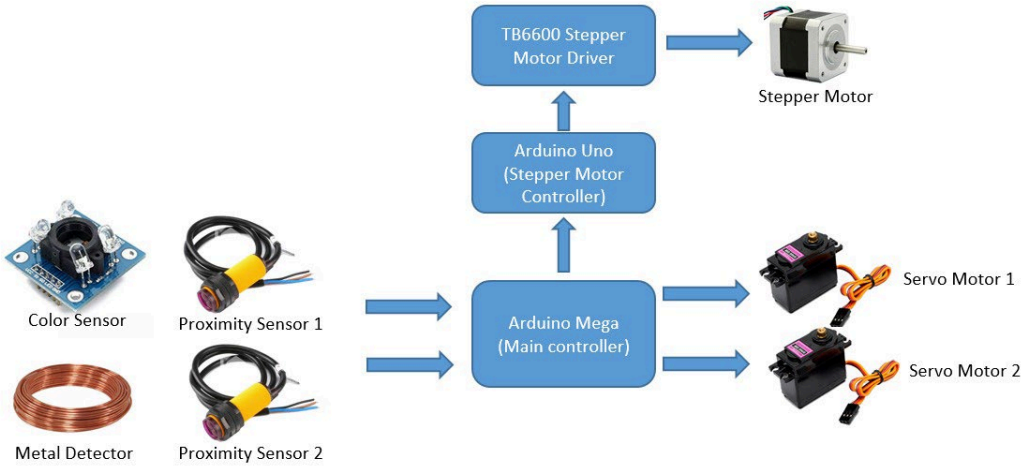

Figure 1. Block diagram of the system

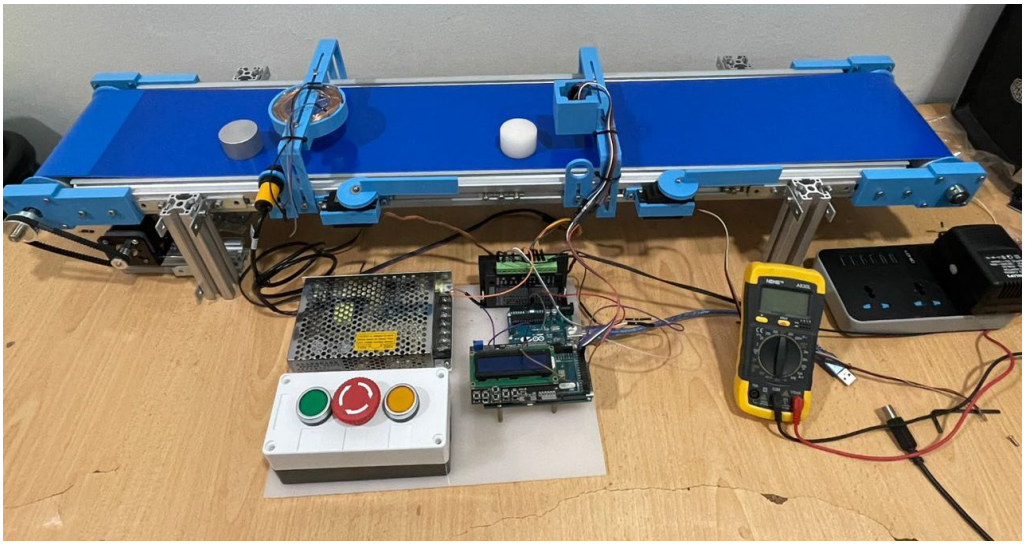

Figure 2. Prototype of the system

3. Novelty and uniqueness

This project introduces a novel approach to integrating affordable, open-source Arduino technology with object detection and conveyor systems to create a dynamic, hands-on learning platform for automation and digitalization. Unlike traditional industrial systems that are prohibitively expensive and complex, this solution provides a cost-effective, scalable alternative tailored to educational applications. Its uniqueness lies in the ability to replicate core industrial functionalities, such as AI-driven object detection, real-time data communication, and actuator control, at a fraction of the cost. The system's modular design and adaptability to dynamic real-world conditions, including variable conveyor speeds and object occlusions, further distinguish it from existing solutions. By democratizing access to

advanced automation technologies, the project bridges the gap between theoretical learning and practical application, making it a transformative tool for institutions seeking to implement Industry 4.0 concepts into their curricula.

4. Benefit to mankind

This project empowers students by providing accessible and practical exposure to advanced automation technologies, equipping them with skills essential for Industry 4.0. By fostering technological literacy, it prepares future professionals to meet the demands of a rapidly evolving, automated workforce. The affordability of this system ensures that institutions with limited resources can offer cutting-edge training, thereby reducing educational inequities. Beyond education, the project promotes broader societal benefits by cultivating a workforce capable of driving innovation, enhancing productivity, and addressing global industrial challenges through automation and digitalization.

5. Innovation and Entrepreneurial Impact

This project fosters a culture of innovation by introducing a practical, low-cost solution that makes automation education accessible to diverse communities. Its modular and open-source design encourages experimentation and customization, enabling educators and learners to develop tailored solutions for specific applications. By empowering students with hands-on experience in automation technologies, the project promotes entrepreneurial thinking, inspiring learners to innovate and create automation-based solutions for real-world problems. Additionally, the system's potential for replication and scalability creates opportunities for small-scale enterprises to develop and distribute affordable educational tools, fostering entrepreneurship within the community.

6. Potential commercialization

The modular, cost-effective nature of this system makes it highly marketable as an educational toolkit for schools, vocational centers, and training institutions. Its affordability and flexibility address a significant gap in the education sector, where traditional industrial systems are often inaccessible. The product could be commercialized as a DIY kit, complete with instructional guides, pre-configured software, and customizable modules, appealing to a wide range of customers. Educational product developers and institutions would benefit from its scalability, enabling tailored solutions for varying curriculum requirements. The global push for STEM and Industry 4.0 training further enhances the system's market potential, creating opportunities for widespread adoption.

7. Acknowledgment

The successful completion of this project was made possible through the guidance and support of colleagues from Electrical Engineering Studies, College of Engineering, Universiti Teknologi MARA, Johor Branch, Pasir Gudang Campus. Contributions and assistance received are sincerely acknowledged with gratitude.

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