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E-PROCEEDING

EXTENDED ABSTRACT

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Welcome Message

RECTOR, UITM KEDAH BRANCH

Assalamualaikum warahmatullahi wabarakatuh,

First and foremost, I would like to extend my deepest appreciation to the organising committee of i-SPiKE 2025 for their steadfast dedication and commitment in making this prestigious event a reality. My heartfelt congratulations to the committee for their tireless efforts in ensuring that i-SPiKE continues to grow as a meaningful and impactful platform for academics, researchers, students, and industry players worldwide.

The theme for this year, "Empowering Minds: Bridging Innovation, Knowledge and Education for a Sustainable Future," is both timely and significant. It reflects our shared responsibility to not only embrace creativity and technological advancement, but also to ensure that innovation directly contributes to sustainable development, equitable education, and the well-being of future generations.

i-SPiKE 2025 provides a dynamic platform for showcasing innovations that address real-world challenges while opening new avenues for collaboration, engagement, and inclusivity. By bridging knowledge, innovation, and education, this symposium strengthens our collective capacity to design solutions that empower communities and inspire positive change.
I am truly impressed by the diversity and calibre of participants in this year's event. The projects and ideas presented highlight the extraordinary creativity and determination of our innovators. I am confident that the insights and solutions shared here will pave the way for continuous advancement in teaching, learning, and innovation.

It is my sincere hope that you will find i-SPiKE 2025 an enriching experience, one that sparks new ideas, builds lasting collaborations, and strengthens our shared vision for a sustainable future. To all participants, I wish you every success, and to the winners, my warmest congratulations.
Once again, I thank the organising committee, partners, and contributors for their invaluable support. May i-SPiKE 2025 continue to inspire and empower minds for many years to come.

Professor Dr. Roshima Haji Said
Acting Rector
Universiti Teknologi MARA (UiTM) Kedah Branch

Welcome Message
(i-SPiKE 2025 CHAIR)

It is my great pleasure to welcome you to the 4th International Exhibition & Symposium on Productivity, Innovation, Knowledge, and Education 2025 (i-SPiKE 2025). This year's theme, "Empowering Minds: Bridging Innovation, Knowledge, and Education for a Sustainable Future," reflects our collective commitment to advancing innovation and fostering meaningful collaboration across academia, industry, and communities.

i-SPiKE 2025 provides a platform for scholars, researchers, students, and practitioners from diverse fields to showcase their ideas, share knowledge, and inspire new solutions to global challenges. We extend our sincere appreciation to all participants and contributors whose efforts and dedication have made this symposium possible.
We hope that this e-proceedings serves not only as a record of the innovations presented but also as a valuable resource that continues to inspire long after the event.

Thank you.

Dr Junaida Ismail
Chair
4th International Exhibition & Symposium on Productivity, Innovation, Knowledge, and Education 2025 (i-SPiKE 2025)

PREFACE

The 4th International Exhibition & Symposium on Productivity, Innovation, Knowledge, and Education (i-SPiKE 2025) marks yet another milestone in our ongoing commitment to fostering innovation, creativity, and collaboration across disciplines. Guided by this year's theme, "Empowering Minds: Bridging Innovation, Knowledge and Education for a Sustainable Future," the event provides a dynamic platform for students, educators, researchers, and professionals to share their ideas, showcase their innovations, and engage in meaningful knowledge exchange.

This year, we are pleased to report that i-SPiKE 2025 received approximately 50 initial submissions, with more than 35 projects successfully advancing to final presentation and exhibition. These projects reflect a rich diversity of innovation, ranging from educational technologies, digital applications, and gamified learning tools to sustainable materials, cultural heritage preservation, and community-focused solutions. Collectively, they embody the spirit of bridging innovation and education to address pressing societal and global challenges.

We sincerely thank all participants, reviewers, and committee members for their invaluable contributions in making i-SPiKE 2025 a success. It is our hope that this e-proceedings will not only serve as a record of the ideas and innovations presented, but also as an inspiration for future collaborations and advancements in the pursuit of sustainable knowledge and innovation.

Assoc. Prof. Dr. Azlyn Ahmad Zawawi
Editor-in-Chief, i-SPiKE 2025 Proceedings

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CATEGORY 1

S&T (YOUNG)

AUTOMATED ROBOT MOVEMENT FOR SORTING (ARMS)

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ABSTRACT

Manual sorting of packages remains a labour-intensive and error-prone process in logistics operations. With increasing demand for efficient material handling, industries are seeking low-cost automation solutions that can enhance throughput and reduce reliance on manual labour. This paper presents the design and implementation of an Automated Robotic Movement for Sorting (ARMS) prototype, developed with affordable components totalling approximately RM 564.75. The system integrates embedded electronics, dual-microcontroller communication, and sensor technology to automate the sorting of packages based on attributes such as colour and height. A conveyor belt system works in tandem with a robotic arm to classify and place objects into designated bins, with real-time status feedback displayed on an LCD interface. The ARMS system achieves reliable pick-and-place operations, demonstrating a 95% success rate. The low cost and versatility of the system make it an ideal solution for higher learning institutions for hands-on training in robotics and automation. It also offers small-to-medium enterprises (SMEs) an affordable entry point into automation, promoting increased productivity without significant financial investment. Troubleshooting and iterative design improvements were crucial in addressing sensor calibration, servo misalignment, and communication issues. Overall, ARMS presents a scalable, cost-effective solution with significant potential for both educational and industrial applications.

Keywords: Automated sorting, embedded systems, Arduino, conveyor system, robotic arm, package identification.

INTRODUCTION

Manual sorting in industries such as logistics and manufacturing is often inefficient and prone to human error, leading to delays and reduced productivity. Automation has emerged as a solution to improve operational efficiency, speed, and accuracy. However, traditional industrial automation systems, such as Programmable Logic Controllers (PLCs), are typically expensive and require specialized programming and maintenance, making them inaccessible for small-to-medium enterprises (SMEs) and educational institutions (Kumar et al., 2018; Mittal & Saxena, 2020). PLCs, while reliable and widely used in large-scale industries, are not practical for smaller operations due to their high upfront costs and technical complexity. As a result, smaller businesses and educational projects need affordable and flexible automation alternatives. Microcontrollers, specifically Arduino-based systems, offer a low-cost, open-source solution that is both flexible and easy to use, making them ideal for low-budget automation projects (Nguyen & Park, 2020). These systems are compatible with a variety of sensors and actuators, enabling rapid development and easy adaptation to different tasks. This paper focuses on the design and implementation of an Automated Robotic Movement for Sorting (ARMS) system. The ARMS system is built using Arduino microcontrollers and low-cost components, totalling RM 564.75. It automates the sorting of packages based on attributes such as colour and height, using sensors and a robotic arm. The system provides a cost-effective solution for both educational institutions and SMEs looking to implement automation at a fraction of the cost of traditional PLC-based systems. ARMS offers a scalable, affordable solution that can be easily customized and upgraded, making it an excellent tool for hands-on learning and small-scale industrial automation.

METHODOLOGY

The Automated Robotic Movement for Sorting (ARMS) system is designed to automate the sorting process of packages based on their height and colour using Arduino microcontrollers. The system consists of a dual-microcontroller architecture, a conveyor belt, sensors for detection, a robotic arm for sorting, and a display for real-time feedback.

System Architecture and Block Diagram

The ARMS system follows a modular design that allows for easy expansion and integration of new components. The system is controlled by two Arduino microcontrollers: the Arduino Mega (master) handles the sensor inputs and robotic arm movement, while the Arduino Uno (slave) controls the conveyor motor. The sensors include a proximity sensor for detecting packages, an ultrasonic sensor for measuring height, and a colour sensor for identifying objects based on colour. The robotic arm, powered by servo motors, picks up the packages from the conveyor and places them into predefined bins based on classification. The LCD display provides real-time feedback to the user regarding the classification results. Figure 1 depicts the block diagram of the ARMS system, whereas Figure 2 illustrates its integration with the conveyor for pick-and-place operations.

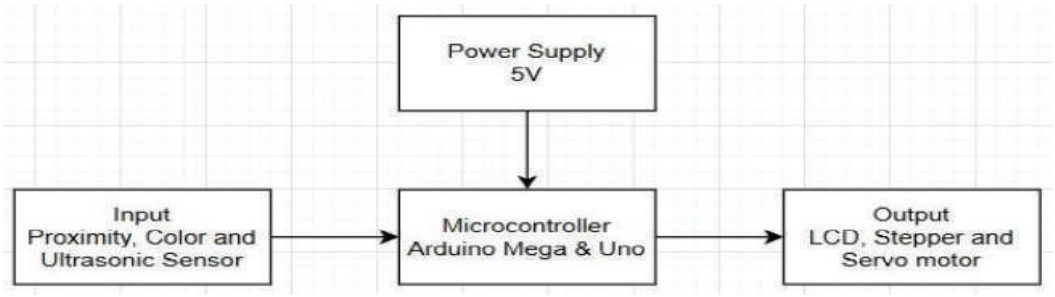

Figure 1. Block Diagram of the ARMS System, Showing the Relationship Between the Sensors, Microcontrollers, and Output Devices (conveyor, robotic arm, LCD)

Figure 2. Robot Arms Attached Together with Conveyor System

System Operation

The operation of the system follows a sequential process. When a package is detected by the proximity sensor, the conveyor belt stops. The ultrasonic sensor then measures the package's height, and the colour sensor classifies it based on its colour. The system displays the classification results on the LCD display. Once classified, the conveyor resumes, and the robotic arm picks up the package and deposits it into the appropriate bin.

Component Selection and Cost

The ARMS system is built using low-cost components, with the total cost of the system being approximately RM 564.75. The components include the Arduino Mega and Arduino Uno for control, proximity sensors, ultrasonic sensors, colour sensors, servo motors, and 3D-printed parts for the robotic arm. The low cost of the components makes the system an accessible option for both educational institutions and small businesses. The 3D-printed components reduce the overall cost of manufacturing, while allowing for customization and easy replacement.

RESULT AND DISCUSSION

The ARMS system was tested for efficiency and accuracy, demonstrating reliable performance in small-scale automation tasks. The conveyor system achieved a response time of less than 0.5 seconds, ensuring accurate positioning for sensor detection. Proximity and colour sensors delivered 100% accuracy under controlled conditions, while the ultrasonic sensor showed an error margin of ±2 mm, sufficient for distinguishing package sizes. The robotic arm achieved a 95% success rate in pick-and-place operations, with errors mainly due to misalignment, and the LCD provided instant feedback with an update time below 0.2 seconds. These results confirm ARMS as a dependable and efficient system. Developed at a cost of RM 564.75, it demonstrates that affordable automation can be achieved using microcontrollers and 3D-printed parts, offering a practical alternative to costly PLC-based systems. Its modular design and use of additive manufacturing enhance scalability and adaptability to various applications. The system's novelty lies in its integration of dual microcontrollers, multiple sensors, and customized 3D-printed components, combining affordability with functionality. Beyond commercial value, ARMS serves as a valuable educational tool, providing students with hands-on experience in embedded programming, sensor integration, and robotic control. For SMEs, it represents a cost-effective entry-level automation solution with potential for future upgrades.

CONCLUSION

This paper presents the Automated Robotic Movement for Sorting (ARMS) system, which integrates low-cost microcontroller-based automation, sensors, and a 3D-printed robotic arm to offer a cost-effective and scalable solution for automated sorting tasks. The system demonstrated a 95% pick-and-place success rate and achieved significant cost savings, totalling RM 564.75 for the entire build. The ARMS system provides a practical, affordable alternative to traditional PLC systems, making it accessible to both educational institutions and small businesses. By utilizing Arduino microcontrollers and 3D printing, ARMS opens up opportunities for hands-on learning in robotics and embedded systems, while also offering a flexible automation solution for SMEs. With future improvements in materials and actuators, ARMS has the potential to become a competitive solution in the growing field of industrial automation.

ACKNOWLEDGEMENT

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