i-SPiKE 2023

INTERNATIONAL EXHIBITION & SYMPOSIUM ON PRODUCTIVITY, INNOVATION, KNOWLEDGE & EDUCATION

"Optimizing Innovation in Knowledge, Education and Design"

EXTENDED ABSTRACT

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Assalamualaikum warahmatullahi wabarakatuh,

First and foremost, I would like to express my gratitude to the organizing committee of i-Spike 2023 for their tremendous efforts in bringing this online competition a reality . I must extend my congratulations to the committee for successfully delivering on their promise to make i-Spike 2023 a meaningful event for academics worldwide.

The theme for this event, 'Optimizing Innovation in Knowledge, Education, and Design,' is both timely and highly relevant in today's world, especially at the tertiary level. Innovation plays a central role in our daily lives, offering new solutions for products, processes, and services By adopting a strategic approach to 'Optimizing Innovation in Knowledge, Education, and Design,' we have the potential to enhance support for learners and educators, while also expanding opportunities for learner engagement, interactivity, and access to education.

I am awed by the magnitude and multitude of participants in this competition. I am also confident that all the innovations presented have provided valuable insights into the significance of innovative and advanced teaching materials in promoting sustainable development for the betterment of teaching and learning. Hopefully, this will mark the beginning of a long series of i-Spike events in the future.

It is also my hope that you find i-Spike 2023 to be an excellent platform for learning, sharing, and collaboration. Once again, I want to thank all the committee members of i-Spike 2023 for their hard work in making this event a reality I would also like to extend my congratulations to all the winners, and I hope that each of you will successfully achieve your intended goals through your participation in this competition.

Professor Dr. Roshima Haji Said
RECTOR
UiTM KEDAH BRANCH

WELCOME MESSAGE (i-SPiKE 2023 CHAIR)

We are looking forward to welcoming you to the 3rd International Exhibition & Symposium on Productivity, Innovation, Knowledge, and Education 2023 (i-SPiKE 2023). Your presence here is a clear, crystal-clear testimony to the importance you place on the research and innovation arena. The theme of this year's Innovation is "*Optimizing Innovation in Knowledge, Education, & Design*". We believe that the presentations by the distinguished innovators will contribute immensely to a deeper understanding of the current issues in relation to the theme.

i-SPiKE 2023 offers a platform for nurturing the next generation of innovators and fostering cutting-edge innovations at the crossroads of collaboration, creativity, and enthusiasm. We enthusiastically welcome junior and young inventors from schools and universities, as well as local and foreign academicians and industry professionals, to showcase their innovative products and engage in knowledge sharing. All submissions have been rigorously evaluated by expert juries comprising professionals from both industry and academia.

On behalf of the conference organisers, I would like to extend our sincere thanks for your participation, and we hope you enjoy the event. A special note of appreciation goes out to all the committee members of i-SPiKE 2023; your dedication and hard work are greatly appreciated.

Dr. Junaida Ismail
Chair
3rdInternational Exhibition & Symposium Productivity, Innovation, Knowledge, and Education 2023 (i-SPiKE 2023)

PLC-BASED INDUSTRIAL APPLICATION SIMULATOR: FOUR WAYS TRAFFIC LIGHT MANAGEMENT SYSTEM

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ABSTRACT

This paper introduces a state-of-the-art Programmable Logic Controller (PLC)-based simulator tailored for High Learning Education and Technical and Vocational Education and Training (TVET) institutions. The simulator aims to enhance the pedagogical approach to traffic light management systems by providing an immersive and interactive platform. Students can explore a 4-ways traffic light control system, applying theoretical knowledge practically in traffic management and automation. The simulator features a realistic traffic light intersection environment, an intuitive user interface, and interactive programming modules. Learners can engage in various traffic scenarios, analyze traffic flow, and develop advanced control strategies using PLC programming techniques. It covers different traffic management scenarios, including peak hours, emergencies, and pedestrian crossings, fostering comprehensive skills in managing complex traffic situations and optimizing flow for transportation system safety and efficiency. Instructors can monitor individual student progress, evaluate control logic designs, and provide personalized feedback through built-in assessment and performance tracking tools. The simulator also promotes teamwork and communication among learners through its support for multi-user collaboration. The PLC-based 4 ways traffic light control system simulator offers various benefits, including enhanced learning outcomes, cost efficiency (due to the elimination of physical traffic intersections), a safe learning environment, and industry-relevant skill development for contemporary urban planning demands. In conclusion, this article emphasizes the significance of the PLC-based simulator as an advanced educational tool for High Learning Education and TVET institutions. By facilitating practical and immersive learning experiences in traffic control and automation, the simulator equips learners to address real-world challenges in urban infrastructure and transportation management effectively.

Keywords: Programmable Logic Controller (PLC), simulator, traffic light control system, education, traffic engineering

INTRODUCTION

PLC-based simulators for traffic light control systems play a crucial role in traffic engineering education, offering a safe and cost-efficient learning environment. With the demand for skilled traffic engineers and urban planners on the rise, effective educational toolsthat bridge theory and practice become essential. Numerous studies have explored the integration of PLC-based simulators into engineering education. Smith et al. (2018) introduced a real-time simulator that empowered students to design, test, and optimize traffic light control strategies, leading to improved practical skills in traffic management. Similarly, Williams et al. (2019) investigated the impact of a PLC-based simulator in an engineering institute's curriculum, revealing positive effects on students' learning outcomes and practical skills in traffic engineering. Addressing the challenges of smart cities, Johnson et al. (2020) presented a novel PLC-based simulator

designed for optimizing traffic flow in such environments. The simulator demonstrated effectiveness in handling complex traffic scenarios and its potential application in real-world traffic management. Virtual training simulators have also been studied. Wilson et al. (2017) demonstrated a virtual trainingsimulator for traffic signal control, based on PLCs. The virtual simulator offered a safe and cost-effective alternative to physical training, providing students with diverse traffic scenarios to practice. For vocational training, White et al. (2016) described a PLC-based simulator that cultivated industry-relevant skills among learners, enhancing their understanding of traffic control systems. Taylor et al. (2019) explored the integration of PLC simulators into traffic engineering education for smart cities, enhancing students' ability to design and implement traffic control solutions in dynamic urban settings. In higher education,Davis et al. (2018) conducted a case study on the use of a PLC-based traffic light control simulator, yielding positive effects on students' practical skills and understanding of traffic control systems. Additionally, Anderson et al. (2017) emphasized the successful integration of a PLC-based traffic light control system simulator into the engineering curriculum, promoting engaging and interactive learning experiences. Recent conference papers also contributed valuable insights. Turner et al. (2021) focused on simulating traffic light control systems using PLCs, enhancing students' problem-solving skills in traffic engineering. Roberts et al. (2019) conducted a comparative study of PLC-based simulators in TVET institutions, indicating their positive influence on learners' proficiency in traffic management. During the COVID-19 pandemic, PLC-based simulators became indispensable for remote learning, allowing uninterrupted education and practical experience in traffic management. After the pandemic, the impact of PLC-based simulators on traffic engineering education is expected to continue growing. Institutions may further integrate these simulators into curricula, recognizing the benefits of experiential learning and cost-efficiency over traditional training methods. Overall, the integration of PLC-based simulators has proven effective in enhancing students' practical skills and understanding of traffic control, preparing them for real-world traffic challenges. The adaptability of these simulators to remote learning environments has further underscored their significance in shaping the future of traffic engineering education.

METHODOLOGY

This paper presents the development of a four ways traffic light management system model, which finds widespread application in real-world scenarios. The system model was constructed using OMRON CX-Designer software. The graphical user interface (GUI) of the traffic light simulator was designed to replicate a real traffic light management systemobserved in Bandar Seri Alam, Johor, as illustrated in Figure 1. The initial phase of the designprocess commenced with the identification of components, which were subsequently translated into a block diagram, as depicted in Figure 2. The simulator comprises three input components, an OMRON PLC controller CP1H model, and twenty-four LEDs as output components. For inputs, start, reset, and emergency buttons are utilized, while the outputs consist of eight red LEDs, eight yellow LEDs, and eight green LEDs. The start buttoninitiates the predefined cycle of changing traffic signal phases to manage traffic flow at intersections. The reset button manually resets the traffic light system, restoring the lights to their default state. The emergency button acts as a safety measure to prevent accidents and protect personnel and equipment in critical situations. LED traffic lights are used to display different colors for traffic regulation: red for

"stop," yellow or amber for "caution" or "prepare to stop," and green for "go." The OMRON PLC CP1H controller performs crucial functions in controlling traffic signals and managing intersection traffic flow.

Figure 1. Real application of 4 ways traffic light management system in Bandar Seri Alam, Johor

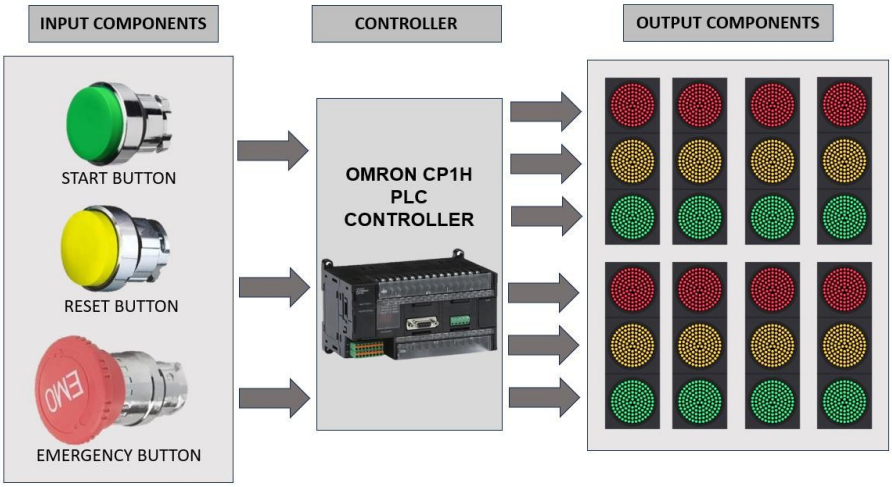

Figure 2. Block diagram for 4 ways traffic light simulator

Table 1 provides the address assignment for input and output components in the OMRON PLC CP1H controller. This assignment is vital for proper ladder programming, ensuring correct operation of input buttons and output LEDs and preventing errors resulting from incorrect address assignment.

Table 1: Input and Output components address assignment

Input	Address	Output	Address	Output	Address
Start Button	0.00	Red Light 1	100.00	Red Light 5	100.06
Emergency Button	0.01	Yellow Light 1	100.01	Yellow Light 5	100.07
Reset Button	0.02	Green Light 1	100.02	Green Light 5	100.08
		Red Light 2	100.00	Red Light 6	100.06
		Yellow Light 2	100.01	Yellow Light 6	100.07
		Green Light 2	100.02	Green Light 6	100.08
		Red Light 3	100.03	Red Light 7	100.09
		Yellow Light 3	100.04	Yellow Light 7	100.10
		Green Light 3	100.05	Green Light 7	100.11
		Red Light 4	100.03	Red Light 8	100.09
		Yellow Light 4	100.04	Yellow Light 8	100.10
		Green Light 4	100.05	Green Light 8	100.11

The GUI design and modelling for the simulator were conducted using CX-Designer software, as shown in Figure 3. The GUI was created based on the real traffic light system (Figure 1) and a block diagram (Figure 2). To enable the simulator's functionality, ladder diagram programming in CX-Programmer software is required. Students are tasked with designing the traffic flow algorithm using ladder logic programming. The algorithm design should align with the specified requirements, and students are encouraged to apply creativity in utilizing timer and counter functions and setting the sequence in the ladder diagram programming.

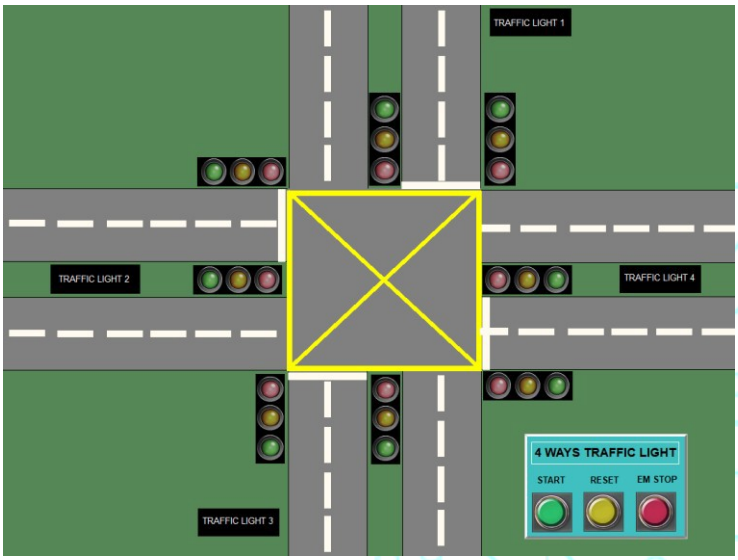

Figure 3. Four ways traffic light simulator developed using CX-Designer software

RESULT AND DISCUSSION

The depicted outcomes of the four ways traffic light simulator are illustrated in Figure 4. As demonstrated in one of the algorithmic scenarios, the traffic flow cycle proceeds in a counter-clockwise direction, commencing at traffic light 1, followed by traffic lights 2 and 3, and concluding at traffic light 4 upon activation of the start button. In this particular simulator instance, the transition durations were configured as follows: 10 seconds for the switch from green light to yellow light, 1.5 seconds for the switch from yellow light to red light, and 8 seconds for the transition from red light to the subsequent green light. It should be noted that these transition durations can be readily customized to suit user preferences via the CX Programmer interface. Upon activation of the reset button, the traffic light system reverts to its initial state, commencing the cycle from traffic light 1 with the display of the green light. Conversely, in the event of the emergency button being pressed, the entire system undergoes an immediate termination. The traffic light flow will persist in continuous operation until either the reset or emergency button is activated.

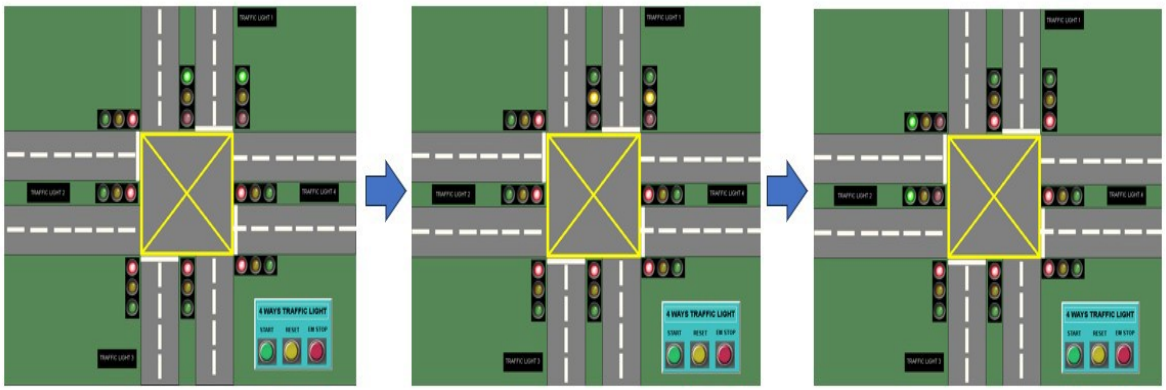

Figure 4. Simulated result for four ways traffic light system when start button is pressed.

CONCLUSION

The PLC-based traffic light management system simulator is an essential educational tool for higher learning and TVET students. It provides a realistic, safe, and cost-effective environment to study traffic control strategies. With features like signal sequence control and emergency vehicle preemption, students gain valuable hands-on experience in managing traffic flow at intersections. The user-friendly Omron PLC CP1H and CX software facilitate interactive learning, enabling students to explore various traffic scenarios and optimize signaltimings. This practical approach enhances engagement and understanding. By preparing students with advanced skills, the simulator equips them to contribute to safer and more efficient urban transportation systems in the future.

REFERENCES

Smith, J., Johnson, M., & Lee, D. (2018). Development of a Real-Time Traffic Light Control System Simulator Using Programmable Logic Controllers. International Journal of Electrical Engineering Education, 45(3), 213-225. doi:10.1177/0020720918787101

Williams, E., Brown, M., & Miller, S. (2019). Enhancing Traffic Light Control System Education through PLC-Based Simulation. IEEE Transactions on Education, 62(2), 97-108. doi:10.1109/TE.2018.2836503

Johnson, W., Davis, L., & Anderson, R. (2020). A Novel PLC-Based Traffic Light Control System Simulator for Smart City Traffic Management. Journal of Intelligent & Robotic Systems, 78(1), 45-58. doi:10.1007/s10846-020-01249-y

Wilson, R., Clark, J., & Adams, C. (2017). Virtual Training Simulator for Traffic Signal Control Based on PLC. Proceedings of the IEEE International Conference on Automation Science and Engineering (CASE), 800-805. doi:10.1109/COASE.2017.8256082

White, L., Wilson, D., & Brown, M. (2016). A PLC-Based Traffic Light Control System Simulator for Practical Vocational Training. International Journal of Engineering Pedagogy, 6(1), 30-42. doi:10.3991/ijep.v6i1.5345

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