A Service Sharing Platform for Hands-on Teaching and Learning in Engineering Education

Xinyue Guo, Zhengxu Zhu, Shuxuan Zhao, Chenlin Yu, Ray Y. Zhong*

Introduction

• Traditional engineering education faces challenges in cultivating students' innovation and hands-on skills, especially with the rapid advancements in technology. Traditional teaching methods, such as lectures and lab sessions, are becoming insufficient to meet the demands of developing real-world problem-solving abilities in students.

• This study proposes a service-sharing platform that integrates 3D printing with engineering education to enhance hands-on learning experiences and foster creativity.

• The platform also emphasizes flexibility, interactivity, and independence, creating an engaging and dynamic learning environment tailored to students' needs.

Objectives

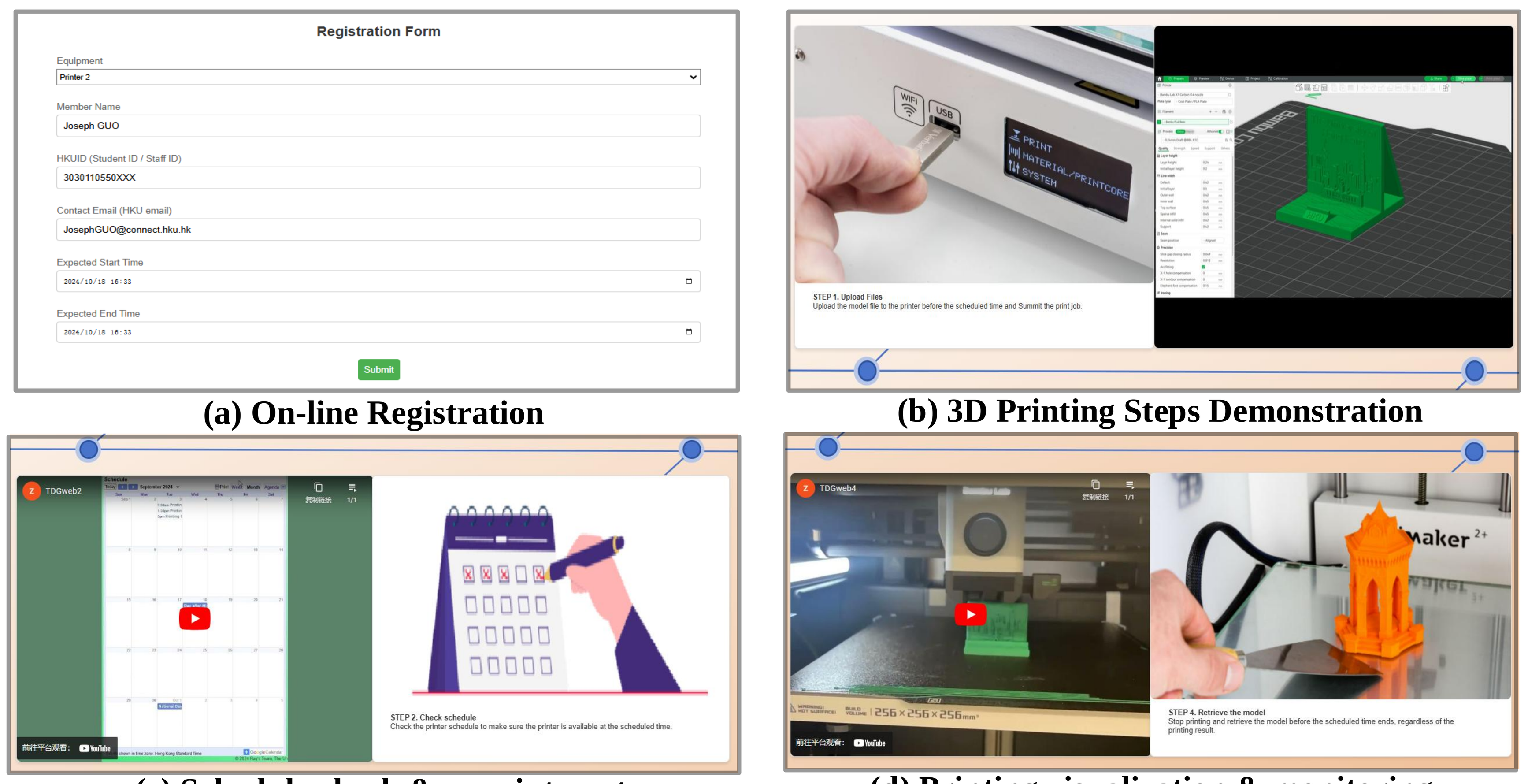
• Build an online platform that combines 3D printing services with modern pedagogical approaches to enhance hands-on learning in engineering education.

• Implement an intelligent booking system to allow students to schedule personalized 3D printing sessions and manage learning resources efficiently.

• Foster creativity, flexibility, and interactivity in engineering education to improve student engagement. Create intelligent resource allocation strategies to maximize teaching resource utilization and enhance learning outcomes.

Methodology

• ***Platform Design:*** The platform integrates a 3D printing booking system with online learning resources. Features include tutorials, real-time monitoring, and a user-friendly interface for personalized scheduling. The printing process consists of four steps: determining printing time, checking the schedule, registering user information, and starting the print.



(a) On-line Registration

(b) 3D Printing Steps Demonstration

(c) Schedule check & appointment

(d) Printing visualization & monitoring

• ***Queuing Model for Resource Allocation:*** Total 3D printing service capacity (C) is determined by: $C = n \times t_{ave}$, where n = number of printers, and t_{ave} = average service time per print job. Capacity is divided into two parts: $C_r = \alpha \times C$, for reservations. $C_o = (1 - \alpha) \times C$, for walk-ins.

• ***Pricing and Optimization:*** Reservation price (P_r) includes a deposit (η) and a final payment ($P_r - \eta$).Walk-in price (P_o) is adjusted dynamically to manage demand and ensure fairness. The platform maximizes total service revenue (Φ) using: $\Phi = P_r \times \min(\lambda_r, C_r) + P_o \times \lambda_o$, where λ_r = arrival rate of reservation students, and λ_o = arrival rate of walk-in students.

Results

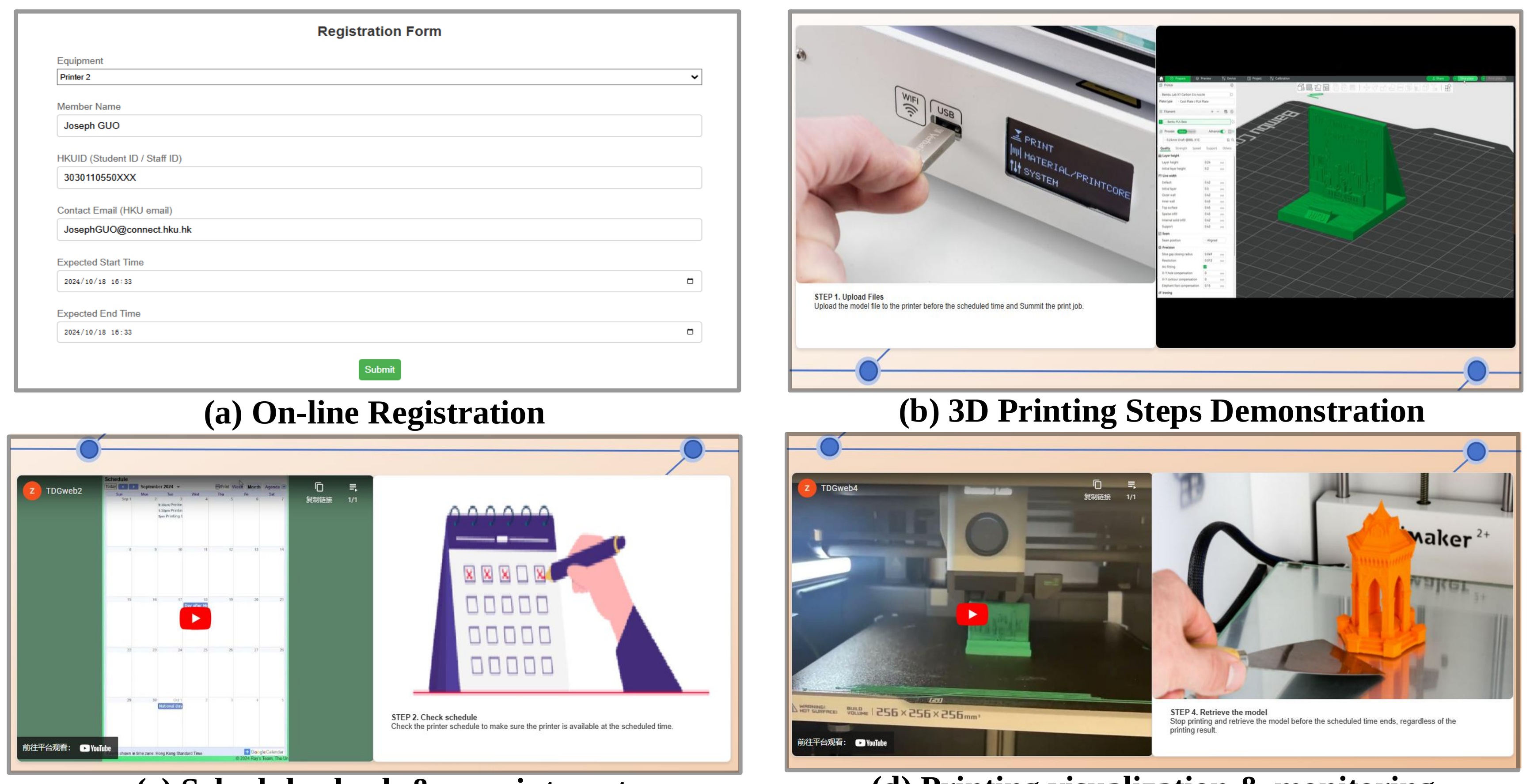
• ***Scenario Analysis:***

Scenario I: High Demand ($\lambda > C$)When total demand exceeds capacity, waiting time increases significantly:$\Omega \approx \lambda / \mu(\mu - \lambda)$A higher deposit ($\eta$) is required to ensure reservation commitment. Reservation prices (P_r) and walk-in prices (P_o) increase to manage demand.

Scenario II: Balanced Demand ($\lambda \leq C$)When demand matches capacity, the system operates stably, minimizing waiting time:$\Omega \approx \lambda / \mu$A larger portion of capacity (α) is allocated to reservations, and walk-in queues are avoided.

• ***Resource Utilization:*** Utilization efficiency (U) is calculated as:$U = (\lambda_r \times t_{ave}) / (n \times t_{ave})$, where λ_r = reservation arrival rate.

• ***Student Feedback and Engagement:*** Real-time monitoring and personalized scheduling significantly improve student satisfaction. Reported outcomes include reduced waiting times and enhanced learning experiences.



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Conclusion

• ***Integration of Technology and Education:*** The platform effectively integrates 3D printing with modern pedagogical approaches, addressing the challenges of hands-on teaching and learning in engineering education. Real-time feedback and personalized scheduling have enhanced the learning experience and improved teaching efficiency.

• ***Enhanced Student Engagement and Learning Outcomes:*** The platform fosters creativity and independence by allowing students to define their own printing tasks and observe the real-time printing process.

• ***Contributions to Future Educational Practices:*** This research provides a foundation for further exploration of technology-driven solutions in engineering education.

Department of Data and Systems Engineering
The University of Hong Kong

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Contact Details: Prof. Ray Y. Zhong
zhongzry@hku.hk