

Referee Report on the PhD Dissertation of Ms. Yuting Ma Institute of Theoretical and Applied Informatics, Polish Academy of Sciences

I have reviewed the dissertation entitled “IoT-Based Decision Making and Passenger Routing for the Emergency Evacuation of Cruise Ships” submitted by Ms. Yuting Ma under the supervision of Professor Erol Gelenbe. The work addresses an important and timely problem: ensuring the safe and efficient evacuation of passengers from cruise ships in emergency conditions. Given the increasing size and complexity of modern cruise vessels, and the catastrophic consequences that can result from accidents, this research is highly relevant both academically and practically.

The dissertation proposes a comprehensive framework that integrates Internet of Things infrastructures, wireless sensor networks, and intelligent routing algorithms to improve evacuation management. The candidate develops a set of methods including centralised and distributed navigation strategies, reinforcement learning-based evacuation planning, and IoT-driven congestion avoidance mechanisms. These approaches are validated through simulation and analytical modeling, with results showing significant improvements in evacuation time and compliance with international safety standards. The appended publications, several of which are in high-impact journals, demonstrate the originality, quality, and international recognition of the research.

The dissertation is well structured, clearly written, and reflects strong independent research capability as well as notable originality. While reviewing the dissertation, I have answered the following questions as requested:

1. Are the themes of the dissertation topical and how are they related to developments in the discipline?

Yes, the dissertation addresses a highly relevant and contemporary issue within the field of emergency evacuation, particularly in the context of cruise ships. The increasing complexity of modern vessels and the associated risks make this research critical to the field of information and communication technology, especially in IoT applications in transportation safety. This theme is timely, as the problem of passenger evacuation has gained increasing attention in both academic and practical contexts, particularly in the wake of past maritime accidents.

2. What is the scientific problem addressed by the Author and has it been accurately formulated?

The scientific problem is the safe and efficient evacuation of passengers from cruise ships during emergencies. Ms. Ma has accurately formulated the problem and identified key challenges, such as ensuring rapid evacuation under complex conditions, optimising routing for large numbers of passengers, and leveraging optimisation and reinforcement learning technologies to assist in the process. This problem formulation aligns well with current technological advancements and the growing demand for safety innovations in transportation.

3. Has the Author solved the problem posed and has he used the right methods to do so?

Yes, Ms. Ma has effectively addressed the problem through the development of a novel IoT-based framework that integrates wireless sensor networks and intelligent routing strategies, including reinforcement learning-based evacuation planning. The methods used are appropriate for the problem, and the dissertation includes robust simulations and analytical models that validate the proposed solutions. The work demonstrates strong technical execution and innovative application of reinforcement learning and IoT.

4. What is the Author's original contribution to the discipline?

Ms. Ma's original contribution lies in the development of an IoT-based decision-making framework for emergency evacuation, which integrates multiple novel approaches for congestion avoidance and dynamic passenger routing. This contribution is original in the sense that it provides a new perspective on how IoT and sensor networks can be applied to large-scale evacuation processes, particularly in complex environments like cruise ships. It expands the current understanding of evacuation planning by incorporating reinforcement learning and dynamic route adjustments.

5. What is the cognitive significance and practical relevance of the author's contribution?

The cognitive significance is in the application of advanced IoT technologies to improve emergency evacuation, an area of increasing interest due to the growing risks associated with modern transportation systems. The practical relevance is significant, as the research offers potential real-world solutions to enhance the safety and efficiency of evacuation procedures on cruise ships, potentially saving lives and ensuring compliance with international safety standards. This work could have a broader impact on other areas of transportation and emergency management.

6. Does the dissertation demonstrate the author's sufficient knowledge of the technical sciences and detailed knowledge in the relevant field of research?

Yes, the dissertation demonstrates comprehensive knowledge of both the technical aspects of IoT infrastructures, wireless sensor networks, and reinforcement learning. Ms. Ma displays an understanding of both the theoretical and practical challenges of emergency evacuation, as well as the methods required to address these challenges. The research integrates interdisciplinary knowledge, blending computer science with transportation safety, which is appropriate for the field of Information and Communication Technology.

7. What are the weaknesses of the thesis?

While the study provides valuable insights, I suggest that the formatting be made more formal and consistent to enhance clarity, and future work could be strengthened by incorporating more detailed modelling of pedestrian behavioural dynamics, particularly the effects of stress on decision-making during evacuation. This could provide a more comprehensive understanding of human responses in emergency situations, which could further refine the evacuation strategies proposed.

Overall, the dissertation represents a substantial and original contribution to the field of emergency evacuation and to the discipline of information and communication technology, and it confirms the candidate's ability as a capable and innovative researcher.

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In conclusion, I find that this dissertation fully meets the requirements for the award of the PhD degree in the field of Engineering and Technology. I therefore recommend that the thesis be accepted and that Ms. Yuting Ma be awarded the degree of Doctor of Philosophy.

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