Reply to Reviewer 2

We are grateful to Reviewer 2 for his/her critical comments that have helped us improve our manuscript. As indicated in the following responses, we have taken all these comments into account in the revised version of our manuscript. Corrections are highlighted in the revised manuscript.

Comments by Reviewer 2

Comment 1

In the article it is not clear enough what progress has been made compared with the current research results.

Response

Thank you for this valuable advice. In the Section 2, we have added table 1 and revised the related statement to clarify the characteristics of GEEC, HGTD, and EEGC for clearing the specific improvements.

"The advantages and disadvantages of the above-mentioned three routing protocols are summarized in table 1.

Table 1. Conventional routing protocols based on game theory in terms of technical strengths and weaknesses.

Protocol	***Advantage***	***Limitation***
GEEC	*Reduced energy dissipation, location awareness*	*Generation of clusters with a single node*
EEGC	*Energy-related payoff definitions*	*Residual energy obviated from threshold function calculation, unoptimized transmission path after clustering*
HGTD	*Satisfactory trade-off between minimizing energy consumption and providing the required services*	*Residual energy excluded from the payoff definition*

However, these studies on routing protocols based on game theory rarely integrate QoS indexes into the game process and generally explore network performance through mixed routing indicators. Therefore, QoS cannot be ensured under external attacks because network invulnerability is not involved in the definition of the game model."

Comment 2

The novelty of the proposals is not sufficiently clear in the article. The differences between the functioning of the proposals and the traditional approaches are also not sufficiently clear.

Response

We have added the related statement to illustrate the main novelty of this study in the Section 6.4 as follows:

"In this study, compared with GEEC, HGTD, and EEGC, a novel invulnerability indicator is introduced to describe the network's QoS sufficiently. Meanwhile, the game-theoretic selection mechanism of CHs balances the invulnerability and residual energy and enhances the robustness of network topology. In addition, the cluster update mechanism based on cluster rotation extends the lifetime of essential nodes and reduces the network energy consumption."

Comment 3

I advise authors to review the References section in order to make its formatting more complete, more homogeneous and in accordance with the journal's rules.

Response

Thank you for pointing this out. We have updated the references in the manuscript.