Response to Reviewer 2’s Comments on Paper
“Throughput Maximization for UAV-Enabled Relaying in Wireless Powered Communication Networks”
(Manuscript ID: sensors-514056)

Dear reviewer,
Thank you very much for your time and effort put in reviewing our manuscript. We also thank you for your valuable comments that helped improve the quality of this paper. In the following, we address your concerns in the order that they are mentioned.

This paper proposes a mobile relaying in wireless communication networks using an unmanned aerial vehicle. Some important related works should be concerned, such as:

1. In Section 2, the relay transmits whole signals which the relay receives from all sources in all of previous sub time slots. Is it right? If it right, I think the relay operates on NOMA protocol not TDMA protocol.

In case of TDMA protocol, there are two hops in each sub time-slot: the first hop for information transmission between each source and the relay, and the second hop for information transmission between the relay and the destination. With other TDMA approaches, at first the relay receives signals of all sources as the authors mentions in the paper, then the relay transmits signal consecutively to the destination.

Response: Thanks for the above comments. In this paper, we design a communication protocol for the UAV relay as shown in Fig. 2 in the manuscript, and we re-plot it below.

Actually, the protocol above is designed based on TDMA. Firstly, we discretize whole period T into N time slots with equal step δt. Then, in order to collect information from sources and deliver data to destination without any interference, each time slot is divided into K+1 subslots, and the operations including WPT, information uploading for each source and information forwarding to destination occupy one dedicated subslot, respectively. Namely, in each time slot n, sources transmit its signal to the relay one by one according to the subslot partition, and relay sends its signal in the final subslot. Hence, the protocol adopted by the relay is TDMA.

In addition, what we want to explain is that in each slot, the relay may not necessarily
transmit whole signals which it receives from all sources in all of previous subslots, as shown in the following figure (i.e., Fig. 12(a) of the revised manuscript).

The picture above clearly shows that within one slot $n$, the relay is not necessary to transmit whole signals received from all sources in all of previous subslots, because its location has an impact on the subslot scheduling. While, if we consider the whole period time $T$, or all time slot $N$, the amount of received signals equal to the amount of transmitted ones.

2. **Please provide the proof for (16).**

**Response**: Thanks for the above comments. In order to make expression (16) more easily comprehended, we have added some explanations in the revised manuscript as follows:

Here we give a brief explanation for (16). First, from above statement, we know the first and second time slot are allocated for WPT and information uploading, respectively. Namely, the information transmit for the relay starts from the third slot. In addition, due to the assumption of processing delay for the relay, resulting in that the last time slot, i.e., the N-$th$ slot, can not be used to operate WIT for sources, otherwise it would cause time resource waste. The information causality indicates that the WIT starts from the 2nd time slot, and the N-$th$ slot can only be used for information forwarding to the destination, i.e., $\tau_{K+1}[N]=1$. It can be easy to prove that, at the optimal solution, the inequality (16) would hold with equality. Otherwise, we can always increase the value of $\tau_{K+1}[j]R_{rd}[j]$ by enlarge the value of $\tau_{K+1}[j]$, which does not violate our design.

3. **In Section 4, there are no comparison between the proposed algorithm and the existing algorithms, i.e, AF relaying.**

**Response**: Thanks for the above comments. In order to show the performance of our
proposed algorithm, we followed Ref. [19] in the revised manuscript and have designed a static UAV case as the benchmark, as shown in Fig. 12. In fact, UAV trajectory design in UAV-enabled communication system is hard to tackle. In the literature, e.g. Ref. [6]-[8], [10]-[13],[19], the authors were absorbed in find a sub-optimal solution to the formulated problem, and measured the performance of the their proposed algorithms by comparing some special cases instead of other different algorithms due to the solution nature.

In general, the AF relaying is two-way relay, which is significantly different from our proposed design. What’s more, adopting AF relaying may be incompatible with our algorithm design. As a result, it seems to be unsuitable to compare our DF relaying with AF relaying. In future, we are going to take UAV-enabled AF relaying as a particular problem to study.

4. Please provide the complexity of proposed algorithms.

Response: Thanks for the above comments. In the revised manuscript, we analyzed the proposed algorithm from convergence and complexity:

3.5. Convergence and Complexity Analysis of Proposed Algorithm

To explain the convergence of the proposed design, we use $G(\tau, P, Q), G_r(\tau, P, Q), G_p(\tau, P, Q)$ and $G_Q(\tau, P, Q)$ to be the objective value of problem (P1), (P1.1) and (P1.3.2), respectively, where $\tau \triangleq \{\tau_k[n]\}, P \triangleq \{p_{kr}[n], p_{rd}\}, Q \triangleq \{q[n]\}$. For any one iteration $i > 0$, we can get the following expressions,

$$G\left(\tau^{(i)}, P^{(i)}, Q^{(i)}\right) \leq G_r\left(\tau^{(i+1)}, P^{(i)}, Q^{(i)}\right)$$

$$= G\left(\tau^{(i+1)}, P^{(i)}, Q^{(i)}\right)$$

Since $\tau^{(i+1)}$ is the globally optimal solution to problem (P1) by solving (P1.1) with given $P^{(i)}$ and $Q^{(i)}$. Considering problem (P1.2) always offers a lower-bounded solution to (P1), hence we can obtain

$$G\left(\tau^{(i+1)}, P^{(i)}, Q^{(i)}\right) = G_p\left(\tau^{(i+1)}, P^{(i+1)}, Q^{(i)}\right)$$

$$= G_p\left(\tau^{(i+1)}, P^{(i)}, Q^{(i)}\right)$$

The equality (44) holds because (20) and (21) are tight bounds for (P1). Similarly, it can be easily obtained

$$G\left(\tau^{(i+1)}, P^{(i+1)}, Q^{(i)}\right) = G_Q\left(\tau^{(i+1)}, P^{(i+1)}, Q^{(i+1)}\right)$$

$$= G\left(\tau^{(i+1)}, P^{(i+1)}, Q^{(i+1)}\right)$$

Based on (42)-(49), we have
As a result, the proposed algorithm is verified to be non-decreasing in iterations. In addition, the objective value of (P1) is upper-bounded, which means that the algorithm is guaranteed to converge.

In the proposed Algorithm 1, the original problem (P1) is decomposed into three subproblems that can be efficiently solved by typical methods as applied in [19], [21] and [22] with low complexity. Then, these subproblems are optimized in an alternate manner. Furthermore, the optimization tool CVX is high-efficiency for solving such convex problems [23], which makes the complexity of Algorithm 1 affordable.

5. To verify effectiveness of proposed algorithms, please add comparison results with the case of fixed energy harvesting duration at each time slot, \( \tau_0 = 0.1, 0.5, 0.9, \ldots \) (s).

Response: Thanks for the above comments. We have added the simulation to show the case of different fixed energy harvesting duration at each time slot in the revised manuscript. The details are also given as follows:

\[
G\left(\tau^{(i)}, P^{(i)}, Q^{(i)}\right) \leq G\left(\tau^{(i+1)}, P^{(i+1)}, Q^{(i+1)}\right)
\]  

(50)
and then decreases. This phenomenon can be well comprehended by combining Fig. 6 with Fig. 10, the operation of WPT in each time slot is not the best choice for delay-tolerant case but for the delay-sensitive case. In general, with the increasing value of $\tau_0[n]$, the less time can be utilized for information transmit in each time slot, so as to result in the rate decrease for large value of $\tau_0[n]$.

6. In Fig. 7, the false detection rate is presented. Please explain the detection threshold after BSM.

Response: Thanks for the above comments. Sorry we can not understand the meaning of BSM, or maybe there is something wrong in this comment.