MHCDMC Rouding

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Abstract

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1 Introduction

With their maneuverability and increasing affordability, unmanned aerial vehicles (UAVs) have many potential applications in wireless communication systems [1]. In particular, UAV-mounted mobile base stations (MBSs) can be deployed to provide wireless connectivity in areas without infrastructure coverage such as battlefields or disaster scenes. Unlike terrestrial base stations (BSs), even those mounted on ground vehicles, UAV-mounted MBSs can be deployed in any location and move along any trajectory constrained only by their aeronautical characteristics, in order to cover the ground terminals (GTs) in a given area based on their known locations.

After a major natural disaster, the ground-based communication facilities are usually destroyed and communication is interrupted, and important communication information is blocked, which endangers the lives of the affected people and aggravates the difficulty of post-disaster rescue. UAVs have wide application prospects in the field of emergency communication because of their advantages such as rapid deployment and the ability to provide effective air-ground line-of-sight links to cover the affected areas by equipping emergency base stations [1].

In order to protect people's life and property and speed up the post-disaster reconstruction and recovery work, we need to provide communication security for users as soon as possible. According to the actual communication demand, some potential optional UAV deployment locations are selected by relying on information such as population distribution and disaster situation. Selecting the minimum number of UAVs to restore the communication network in that area under the constraints of communication needs is a critical issue. Since larger UAVs have larger energy reserves compared to smaller UAVs, larger UAVs can transmit signals with higher power and have greater bandwidth capacity to obtain better signal coverage performance. Therefore, in this paper we assume that the UAV base station with higher signal transmitting power has a larger bandwidth capacity.

2 Related work

related work

3 System model

In a disaster area, we have pre-planned m loci and possible MBSs to be deployed in. Although deploying MBSs in each location can satisfy the communication needs of all users, it is very inefficient and impractical. We need to select as few loci as possible to deploy the corresponding MBSs as soon as possible to restore communication services for n users. We denote the set of users and MBS loci by U and A, respectively. For each user $u_j \in U$, there is a bandwidth requirement BR_j. The signal transmit power of MBS $a_i \in A$ is p_i, and the bandwidth resource is limited to BW_i. In order to resume communication for users as soon as possible while ensuring that the communication signal-to-noise ratio of all users is not less than $SINR_{min}$, we need to select as few deployed MBSs as possible. we introduce decision variables x_{ij} and y_i. y_i denotes whether to choose a_i as the final MBS deployment policy, and when $y_i = 1$ indicates that MBS a_i is chosen. x_{ij} is used to indicate whether to make a_i allocate bandwidth resources for u_j to provide services, and when $x_{ij} = 1$ indicates that u_j is served by a_i.

The communication between the UAV-enabled MBS and the user uses an air-to-ground communication link in the sub-6 GHz band, where Line of Sight (LoS) dominates. A The path loss between u_j and a_i can be expressed as:

$$L_{ij}(\mathrm{dB}) = 20\lg(d_{ij}) + 20\lg(\frac{4\pi f}{c}) + \eta_{LoS}, \tag{1}$$

where d_{ij} denotes the distance between a_i and u_j, f denotes the carrier frequency, c represents the speed of light, and η_{LoS} represents the shadow fading loss of LoS, which is a constant. the signal-to-noise ratio between a_i and u_j is:

$$SINR_{ij} = \frac{G_{ij}p_i}{N_I + N_0}, \tag{2}$$

G_{ij} denotes the channel gain between a_i and u_j, N_I denotes the interference noise power in this environment, and N_0 denotes the white noise power. The channel gain G_{ij} is affected by the path loss and satisfies the following relationship:

$$G_{ij}p_i(\mathrm{dB}) = p_i(\mathrm{dB}) - L_{ij}(\mathrm{dB}). \tag{3}$$

According to the above relationship, u_j's data rate DR_j can be expressed as

$$DR_j = BR_j \log_2(1 + SINR_{ij}). \tag{4}$$

Based on the above definition, we can get the integer programming form of the problem.

$$\begin{aligned}
\min \quad & \textstyle\sum_{a_i \in A} y_i && && (5)\\
s.t. \quad & x_{ij} \le y_i && \forall u_j \in U,\ \forall a_i \in A. && (5a)\\
& \textstyle\sum_{u_j \in U} (x_{ij} \cdot BR_j) \le y_i \cdot BW_i, && \forall a_i \in A. && (5b)\\
& \textstyle\sum_{a_i \in S} x_{ij} = 1, && \forall u_j \in U. && (5c)\\
& x_{ij} = 0, && \forall u_j \in U, \forall a_i \in A \text{ such that } SINR_{ij} < SINR_{\min}, && (5d)\\
& x_{ij} \in \{0,1\}, && \forall u_j \in U, \forall a_i \in A && (5e)\\
& y_i \in \{0,1\}, && \forall a_i \in A. && (5f)
\end{aligned}$$

Constraint (5a) means that u_j can be served by a_i only after the MBS a_i is selected. Constraint (5b) is the bandwidth resource capacity resource constraint of each MBS, the sum of bandwidth demand of users it serves cannot exceed its own capacity. Constraint (5c) of indicates that every user must be served. Constraint (5d) means that if u_j is served by a_i, then the SINR of u_j has to be greater than $SINR_{min}$. Constraints (5e) and (5f) are two integer decision variable constraints. We relax the integer programming (5) to be able to obtain its linear programming (6):

$$\begin{aligned}
\min \quad & \textstyle\sum_{a_i \in A} y_i && && (6)\\
s.t. \quad & x_{ij} \le y_i, && \forall u_j \in U, \forall a_i \in A. && (6a)\\
& \textstyle\sum_{u_j \in U} (x_{ij} \cdot BR_j) \le y_i \cdot BW_i, && \forall a_i \in A. && (6b)\\
& \textstyle\sum_{a_i \in S} x_{ij} = 1, && \forall u_j \in U. && (6c)\\
& x_{ij} = 0, && \forall u_j \in U, \forall a_i \in A \text{ such that } SINR_{ij} < SINR_{\min}, && (6d)\\
& x_{ij} \ge 0, && \forall u_j \in U, \forall a_i \in A && (6e)\\
& 0 \le y_i \le 1, && \forall a_i \in A. && (6f)
\end{aligned}$$

$$\varepsilon^p = \frac{{p_i}' - p_i}{p_i} \tag{7}$$

$$\varepsilon^{SINR} = \frac{SINR_{\min} - SINR_{\min}'}{SINR_{\min}} \tag{8}$$

4 Rounding

In this section, we present an efficient rounding algorithm for the problem.

5 Experimental Results

6 Conclusion and future work

We feel that the local assignment algorithm in Section will find application in related areas.

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References