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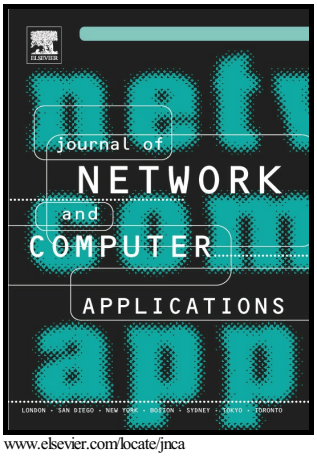

www.elsevier.com/locate/jnca

PII: S1084-8045(17)30271-0
DOI: http://dx.doi.org/10.1016/j.jnca.2017.08.008
Reference: YJNCA1954

To appear in: *Journal of Network and Computer Applications*

Received date: 5 December 2016
Revised date: 7 March 2017
Accepted date: 22 August 2017

Cite this article as: Qinying Lin, Houbing Song, Xiaolin Gui, Xiaoping Wang and Saiyu Su, A Shortest Path Routing Algorithm for Unmanned Aerial Systems based on Grid Position, *Journal of Network and Computer Applications,* http://dx.doi.org/10.1016/j.jnca.2017.08.008

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A Shortest Path Routing Algorithm for Unmanned Aerial Systems based on Grid Position

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Abstract

The unmanned aerial system (UAS), as a typical aeronautical Ad-hoc network (AANET) system, which is composed of unmanned aerial vehicle clusters has a lot of advantages such as flexible deployment, excellent cost-benefit ratio and free from the effect of environment.It will be an important part of the space-sky information network in the future. Due to the fast-moving of nodes in AANET/UAS, the topology changes frequently. The routing overhead becomes huge and inefficient, and connectivity keeping becomes difficult. In this paper, a shortest path routing algorithm based on grid position no center(GPNC-SP algorithm) is proposed, which uses the logical grid distance to replace the original Euclidean distance to reduce the sensitivity of fast-moving nodes. This algorithm automatically computes and maintains the adjacency relationship and topology structure by perception and updating algorithm and adopts Dijkstra algorithm to achieve the shortest routing path. Also, a regional reconstruction strategy(RSS) is designed to optimize the routing path dynamically. At the same time, two metrics, i.e., the percentage of the effective communication area(P_{eca}%) and the sensitivity with logical grid size (S_g) are used to determine the optional scope of logical grid width. Comparing with the two traditional typical routing protocols (DREAM and DSDV algorithms), this algorithm sacrifices a certain degree of communication distance to achieve better performances of network overhead, link stability, and calculating speed. The final simulation experiments under the Matlab environment demonstrate the effectiveness and practicality of this algorithm.

Keywords: Unmanned Aerial System, Aeronautical Ad-hoc Network, Routing Algorithm, Grid Position, Regional Reconstruction Strategy

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1. Introduction

The aeronautical Ad hoc network (AANET) is a type of mobile Ad hoc network (MANET) composed of aircrafts as nodes in the network (Li et al. [1]). It could provide an efficient method for a dispersed set of nodes to establish communication without infrastructure support (e.g. Sakhaee et al. [2], Grodi et al. [3]), and the self-organizing multi-hop feature of AANET could expand the connectivity over line-of-sight(LOS) limitation of radio and help to extend the communication scope (Zhou et al. [4]). The AANET would play an irreplaceable role of temporarily expanded bandwidth in the remote areas with mountains, oceans, deserts, disaster areas, war zones or under the other conditions where communication resources are needed. For example, if the communication network is interrupted by a strong earthquake, an AANET for information transmission could be established in the affected zone. In the battlefield area, the communication relay platforms could be formed temporarily to send the battlefield information back to the control center.

Recently, the unmanned aerial systems (UASs) as typical AANET systems are emerging and have been playing an increasingly important role in military and civilian operations due to their exceptional operational advantages, such as high-risk mission acceptance and ultra-long endurance capabilities, which cannot be reasonably performed by manned aircraft (Nadella et al. [5]). According to a report of the US Department of Transportation (US Department of Transportation. [6]), the number of UAS in the USA will increase from a few hundred in 2015 to over 230,000 in 2035 (Matolak et al. [7]). UASs are experiencing a tremendous interest in both academia and industry(Louali et al. [8]), it will open a new way for the internet of things (IOT) era with more and more challenges (e.g. Sun et al. [9], Song et al. [10], Jeschke et al. [11]).

UAS network or AANET is a wireless network that is characterized by highly dynamic topology, varying network size, heterogeneous nodes, time-varying channels and low density, etc. (Govindaswamy et al. [12]). Those features pose many challenges, such as the constantly changing network topology, the unstable communication quality of wireless transmission channel, the low efficiency of the routing overhead and the difficulties in keeping connectivity. Especially for an UAS with the high-speed nodes, the dynamic changes of its topology are highly significant. Thus there is a need for a more efficient protocol to maintain the routing under the constantly changing topology (Nasipuri et al. [13]). Aiming at these problems stated above, a GPNC-SP routing algorithm is proposed in this paper. Simulation results show that GPNC-SP achieves higher efficiency and stability than the traditional algorithms based on

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