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# Link Quality and Load Balancing Multipath Geographic Routing for Wireless Multimedia Sensor Networks

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## ABSTRACT

Multimedia applications in wireless multimedia sensor networks (WMSNs) demand a high level of quality of service (QoS) requirements. The multipath routing approach is considered as an effective solution to meet these requirements. However, the high-energy consumption in WMSNs is a critical concern for lifetime of network contains sensor nodes with limited battery. Many proposed works have designed multipath routing protocols to provide load balancing between discovered paths, although there is a trade-off between power efficiency and data delivery. This paper proposes a link quality and load balancing multipath geographic routing (LQLB-MGR) protocol for WMSNs. This protocol consists of two phases. The first phase is responsible to find multiple node-disjoint paths with high link quality and the second phase allows load balancing between the discovered paths based on nodal residual energy. Simulation results show that LQLB-MGR provides better performance compared to other protocols.

## KEYWORDS

ETX, Geographic Routing, Link Quality, Load-Balancing, Multipath Routing, Nodal Residual Energy, Node-Disjoint, WMSNs

## INTRODUCTION

A Wireless Multimedia Sensor Network (WMSN) consists of a large number of heterogeneous sensor nodes densely deployed in the sensing area. These sensor nodes are equipped with multimedia devices such as microphones and cameras that allow retrieving multimedia data such as still images, video, audio streams, as well as scalar data. WMSNs offer strong support for a wide range of applications such as advanced health care (Koyuncu et al., 2019), traffic management, environmental monitoring (Yang et al., 2018), multimedia surveillance, automated assistance, smart homes, industrial process control and son on. WMSNs have more additional requirements and challenges than traditional WSNs (Lu et al., 2015, 2016, 2018), such as acceptable jitter, high bandwidth, bounded end-to-end delay, and low frame loss ratio. In addition, WMSNs have many resource constraints in terms of memory space, energy and processing capacity, which makes routing over this class of networks a challenging task.

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The characteristics of multimedia content (large volume of data) and network resource constraints decrease the network reliability, which affects the quality of service and makes routing more challenging in WMSNs. Multipath routing strategy is considered as a promising solution in WMSNs (Chikh & Lehsaini, 2018; Kusuma & Subramanyam, 2017). This routing strategy involves multiple routing paths between a pair of nodes (source node and base station) and allows to send the data packets through these routing paths. Recent works such as (Al-Ariki & Swamy, 2016; Hasan et al., 2017) have shown that the main objective of multipath routing protocols is to guarantee different QoS parameters: less end-to-end delay, aggregate bandwidth, load balancing over different routing paths, achieve reliable delivery, increase throughput and allow fault- tolerance. Furthermore, because geographic routing is distinguished by its particular advantages i.e. it does not need maintenance of the routing tables and path construction during data transmission operation, we use this routing strategy in the proposed protocol. Geographic routing is a forwarding approach in which the routing of data packets is done based on localization information of sensor nodes. Thereby, to make transmission decisions in this approach; a node should know its location, the locations of its 1-hop neighbors and that of the base station. Many multipath geographic routing protocols for WMSNs have been proposed in the literature such as (Aswale & Ghorpade, 2018b; Bouatit et al., 2016; Chikh & Lehsaini, 2020; Medjiah et al. 2010). These protocols establish multiple disjoint routing paths between the source node and the base station in WMSNs.

Disjoint path establishment strategies illustrate the independence between paths in terms of shared resources (nodes and links). These strategies attempt to select disjoint routing paths between a pair of nodes (source node and base station) based on the degree of independence of each routing path. Disjoint multipath routing protocols can accomplish bandwidth optimization and higher reliability than multipath routing protocols in which the problem of overlapping and congestion at node level can weaken their performance.

This paper proposes a Link Quality and Load Balancing Multipath Geographic Routing protocol (LQLB-MGR) in order to achieve energy efficiency and to meet the QoS requirements of multimedia applications in WMSNs.

The remainder of this paper is organized as follows. Section II discusses the existing geographic multipath routing protocols related to WMSNs. Section III presents the specific implementation of the proposed routing protocol. Section IV shows the simulation results and section V concludes this paper.

## RELATED WORK

Due to various advantages of multipath routing over single path routing, multipath routing is considered as a suitable solution to guarantee the desired level of QoS in WMSNs. Many multipath geographic routing protocols have been proposed to satisfy multimedia QoS requirements in WMSNs. Moreover, disjoint multipath routing protocols can achieve bandwidth optimization and high reliability than multipath routing protocols. A large number of research works focuses on routing data through multiple disjoint paths in WMSNs. In this section, we present and discuss the most famous routing protocols designed for WMSNs in the literature.

In (Shu et al., 2010), the authors proposed a geographic greedy forwarding routing protocol, called TPGF. The proposed protocol bypasses holes and explores one or more node-disjoint shortest paths. It consists of two phases. In the first phase, TPGF discovers all possible shortest paths and in the second phase (path optimization phase), it removes all circles path, releasing the redundant nodes. TPGF is suitable for WMSNs. However, it does not guarantee a long network lifetime since it selects the same path for a fixed topology.

The authors of (Chen et al., 2007) proposed a directional geographical routing protocol (DGR). This protocol establishes a number of disjoint paths between a source node and the base station to transmit parallel real-time video streams. However, DGR protocol suffers from the energy bottleneck problem. To overcome the weaknesses of DGR (Chen et al., 2012) proposed an enhanced of DGR,