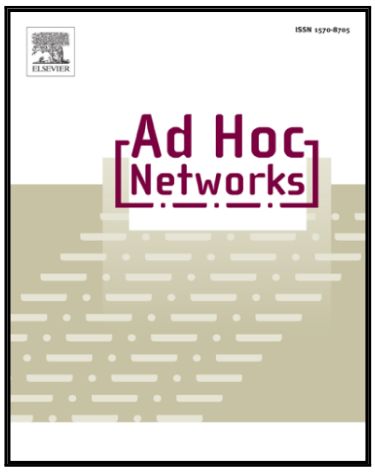

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Performance Evaluation of Unmanned Aerial Vehicles in Automatic Power Meter Readings

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Abstract

Typically, the electric power companies employ a group of power meter readers to collect data on the customers energy consumption. This task is usually carried out manually, which can lead to high cost and errors, causing financial losses. Some approaches have tried to minimize these problems, using strategies such as discovering the minimal route or relying on vehicles to perform the readings. However, errors in the manual readings can occur and vehicles suffer from congestion and high fuel and maintenance costs. In this work, we go further and propose an architecture to the Automatic Meter Reading (AMR) system using Unmanned Aerial Vehicles (UAV). The main challenge of the solution is to design a robust and lightweight protocol that is capable of dealing with wireless communication collisions. Therefore, the main contribution of this work is the design of a new protocol to ensure wireless communication from UAV to the power meters. We validated and evaluated the architecture in an urban scenario, with results showing a decrease of time and distance when compared to other approaches. We also evaluated the system proposed with Linear Flight Plan, the *Ant Colony Optimization* and *Guided Local Search* metaheuristic. Our mechanism attains an improvement of 98% in reducing the message collisions and reducing the energy consumption of the power meters.

Keywords:
Automatic Meter Reading, Unmanned Aerial Vehicles, Wireless Sensors Networks, Message Collision

1. Introduction

In recent years, the use of unmanned aerial vehicles (UAVs) in civil applications has been increasingly higher. These aircraft vary in size and capacity. They can be widely fitted with various devices, e.g. GPS, video/image, one or more wireless communication technologies and multiple sensors. Therefore, new solutions with UAVs have been developed to automate everyday tasks. One such approach is an Automatic Meter Reading (AMR) system, which corresponds to the collection of information from customers and remote transmission of information from power meters, water, or gas consumption. This collection is done without human intervention for administrative purposes, e.g. billing, data analysis or identification of problems [8, 9, 5, 32, 3]. This can significantly reduce the cost of logistics and operation, hence reducing the final price of the hired service [10].

The AMR systems can be classified into three categories [2, 15]: *i)* walk-by, in which employee carries a smartphone or a specific device running the data collector application and enters each consumer unit, and; *ii)* drive-by, which consists of the installation of a data collection device and application in a vehicle. The reader (vehicle with a device and software) performs the consumption meter readings by wireless communication between the collector and the meters, while the car passes along the streets. Finally, in *iii*) fixed network, a network infrastructure automatically captures data consumption, linking the meter and a central computer by a specific network.

The main disadvantages of the current approaches are as follows: the walk-by category takes an undesirable high amount of time, with higher costs associated with reading collection, since the reader must walk around every consumer unit. The drive-by category requires the car to travel through all streets, suffering from traffic jams. Finally, the fixed network category usually consists of a wireless sensor network (WSN), which ensures that the AMR system is capable of reading and delivering the data through multi-hop communication [4, 7]. In this approach, the network topology can impair collection of information, since it might fail in gateway network nodes and cause significant delay and/or loss of data of the reading. In addition, the deployment of a network infrastructure, which con-

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