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LiMoSense – Live Monitoring in Dynamic Sensor Networks

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Abstract

We present LiMoSense, a fault-tolerant live monitoring algorithm for dynamic sensor networks. LiMoSense uses gossip to dynamically track and aggregate a large collection of ever-changing sensor reads. It overcomes message loss, node failures and recoveries, and dynamic network topology changes. We formally prove correctness of LiMoSense; we use simulations to illustrate its ability to quickly react to network and value changes and provide accurate information.

1 Introduction

The subject of environmental monitoring is gaining increasing interest in recent years. Monitoring is necessary for research, and it is critical for protecting the environment by quickly discovering fire outbreaks in distant areas, cutting off electricity in the event of an earthquake, etc. In order to perform these tasks, it is necessary to perform constant measurements in wide areas, and collect this data quickly. In years to come, we can expect to see sensor networks with thousands of light-weight nodes monitoring conditions like seismic activity, humidity or temperature [1, 2]. Each of these nodes is comprised of a sensor, a wireless communication module to connect with close-by nodes, a processing unit and some storage. The large number of nodes prohibits a centralized solution in which the raw monitored data is accumulated at a single location. Specifically, all sensors cannot directly communicate with a central unit.

Fortunately, often the raw data is not necessary. Rather, an *aggregate* that can be computed *inside the network*, such as the sum or average of sensor reads, is of interest. For example, when measuring rainfall, one is interested only in the total amount of rain, and not in the individual reads at each of the sensors. Similarly, one may be interested in the average humidity or temperature rather than minor local irregularities.

In such settings, it is particularly important to perform *live monitoring*, that is, to constantly obtain a timely and accurate picture of the ever-changing data. For example, for disaster avoidance one must quickly propagate changes such as a rapid temperature incline that indicates a fire outbreak, or an increase in seismic activity that indicates an earthquake. In this paper we introduce and tackle this problem of live monitoring in a dynamic sensor networks. This problem is particularly challenging due to the dynamic nature of sensor networks, where nodes may fail and may be added on the fly, and the network topology may change due to battery decay or weather change. The formal model and problem definition appear in Section 3.

Although many works have dealt with data aggregation in sensor networks, they have concentrated on a single aggregation iteration, assuming the sensor reads do not change during this